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ON NEW GENERA AND SPECIES OF FISHES.

By J. DOUGLAS OGILBY.

Read before the Royal Society of Queensland, March 23rd, 1907.

An analysis of the following paper shows that it deals in one way or another with 38 species of fishes, all but two of which belong to Queensland. The addition of these 36 species to the fauna of the State is due to the enterprise and acumen of the members of the Amateur Fishermen's Association of Queensland, and of those friends, equally of both sexes, who, though as yet, unfortunately, not members, have spared neither time nor trouble in collecting and forwarding objects of interest. The fact that such an addition has been made to our fauna during the short space of twelve months through the medium of a comparatively small and struggling Association, calls attention to some points of profound interest to all those to whom the future welfare of our great State is a matter of thoughtful study. Primarily it emphasizes the magnitude of the work which still remains to be done in elucidating the problems connected with the marine zoology of the State; and it has to be remembered that with this elucidation is intimately connected an industry, which, being unaffected either by drought or flood, is more stable and permanent than either pastoral or mining pursuits—which Nature brings in profuse abundance to our very doors—which recuperates itself for the heavy annual toll which we take from it without the cost of a penny piece to the community—and which, though now small and neglected, cannot fail in time to be one of the most reliable as well as the most valuable assets of the State. Secondarily it proves the utility of this and kindred Associations, so long as they keep ever in view that the primal reason of their existence is to encourage the preservation of our fishes, and to foster the development of our fisheries; these two objects can only be successfully accomplished

by increasingly protecting the nurseries of our food-fishes from the onslaughts of ignorance and greed. Finally, it demonstrates in no uncertain way that this Association is worthy of a more intelligent support, both financial and sympathetic, from Parliament and the public, since the work is done in the common interest of all, without reward, save in the consciousness of worthy work worthily performed.

All the fishes referred to in this paper, whether types or otherwise, are in the collection of the Amateur Fishermen's Association of Queensland.

The general results attained in this paper may be most advantageously shown by dividing the analysis referred to above into different sections as follow :—

a. Proposed new genera (4).

BRACHÆLURUS ; fam. *Orectolobidæ* ; type, *B. colcloughi* Ogilby ; v. infra.

CIRRISCYLLIUM ; fam. ead. ; type, *Chiloscyllium modestum* Gunther, Proc. Zool. Soc., 1871, p. 654, pl. LIV : Queensland.

PTENONOTUS ; fam. *Exocœtidæ* ; type, *Exocœtus cirriger** Peters, Mon. Akad. Berlin, 1877, p. 555, pl.—fig. 1 : China.

MEROGYMNUS ; fam. *Opistognathidæ* ; type, *M. eximius* Ogilby ; v. infra.

b. Proposed new species (11).

1. HETERODONTUS BONÆ-SPEI ; fam. *Heterodontidæ* ; Table Bay, S. Africa.
2. BRACHÆLURUS COLCLOUGHI ; fam. *Scyliorhinidæ* ; Moreton Bay.
3. DASYATIS FLUVIORUM ; fam. *Dasyatidæ* ; Brisbane River.
4. EXONAUTES FULVIPES ; fam. *Exocœtidæ* ; Lord Howe Island.
5. TRACHINOTUS VELOX ; fam. *Carangidæ* ; Moreton Bay.
6. APOGONICHTHYS NEBULOSUS ; fam. *Apogonidæ* ; Brisbane River.
7. HYPOPLECTRODES JAMESONI ; fam. *Serranidæ* ; Moreton Bay.
8. PARAPLESIOPS POWERI ; fam. ead. ; Moreton Bay.

* This species has so far been recorded from the China Sea only.

9. MEROGYMNUS EXIMIUS; fam. *Opistognathidæ*; Snapper Grounds off Moreton Bay.
10. PSEUDUPENEUS JEFFI; fam. *Mullidæ*; Brisbane River.
11. SPHEROIDES PERLEVIS; fam. *Tetraodontidæ*; Moreton Bay.

ORECTOLOBIDÆ.

BRACHÆLURUS *gen. nov.*

Form rather short and stout, the distal region of the tail scarcely elevated above the dorsal plane. Head moderate and but little depressed, with rather short, broadly rounded snout. Nasal valve folded, with a prominent cirrus. Mouth inferior, transverse, of moderate size, nearer to the eye than to the tip of the snout, with well developed labial grooves, which are not continuous across the symphysis of the lower jaw, behind which is a conspicuous longitudinal groove. Teeth similar in both jaws, arranged in many series, small, and tricuspid. Eyes small, elongate-oval, with horizontal pupil; spiracles large, below and behind the eye. Posterior gill-slit largest, rather nearer to the fourth than the remaining pairs are to one another, the three last slits above the base of the pectoral fin. Tail a little longer than the head and trunk. First dorsal fin originating above the base of the ventrals, and subequal in size to the second; anal fin low, close to the caudal: caudal fin with the upper flap feebly, the lower moderately developed and notched near the tip; a slight notch between the lobes: pectoral and ventral fins large. Skin covered with minute, smooth, lozenge-shaped scales Ovoviviparous. βραχύς short; αἴλουρος, a cat).

Small ground sharks from the coast of southern Queensland, forming a connecting link between the oviparous *Hemiscylliinæ* and the ovoviviparous *Orectolobinæ*. Type *Brachælurus colcloughi*. (v. infra, p. 4).

Waite's family *Hemiscylliidæ*, characterized "mainly by having the anal fin behind the second dorsal and in being ovoviviparous"* will have to lapse, owing to my announcement of the oviparity of *Chiloscyllium*†, which necessitates a rearrangement of the scyllioid sharks, of

* Waite, Rec. Austr. Mus., iv, 1901, pt. i, p. 32.

† Ogilby, Proc. Roy. Soc. Queensl., xx, 1906, p. 27.

which I am only prepared to acknowledge two families, the *Scyliorhinidæ* with 5 genera and the *Orectolobidæ* with 9 genera.

It also necessitates the formation of a second new genus for the reception of Günther's *Chiloscyllium modestum* —the very species on which Mr. Waite relied for the foundation of his family—but which is not strictly congeneric with *Brachælurus* and necessarily much less so with *Hemiscyllium.*

CIRRISCYLLIUM *gen. nov.*

Differs from *Brachælurus* in the larger, wider, and strongly depressed head; in the anterior position of the mouth, which is well in advance of the middle of the eye; in the ovate spiracles, which are only partly behind the eye; in the more posterior insertion of the anal fin, which is approximate to and far overlaps the caudal; and in the much larger scales. (*cirrus*, a lock of hair, here signifying a "tentacle"; *Scyllium*, an allied genus = *Scyliorhinus*: in allusion to the great development of the nasal cirrus in comparison with that of the *Hemiscylliinæ*).

Type—*Chiloscyllium modestum* Günther.

Coasts of Queensland and New South Wales.

BRACHÆLURUS COLCLOUGHI *sp. nov.*

Body robust, its depth $7\frac{5}{8}$ in the total length. Width of head equaling its depth and $\frac{2}{3}$ of its length, which is rather less than $\frac{2}{3}$ of the trunk and $5\frac{5}{7}$ in the total length; upper profile of head evenly rounded; preoral length $\frac{1}{3}$ of that of the head. Anterior angle of nostril equidistant from the mouth and the tip of the snout; internasal width about equaling the preoral length and $\frac{8}{9}$ of the width of the mouth; nasal cirrus $\frac{5}{7}$ of the preoral length, not extending to the lower labial groove, and $1\frac{1}{2}$ time the diameter of the eye in length. Mouth much nearer to the eye than to the tip of the snout, its width $2\frac{5}{7}$, that between the outer angles of the labial grooves $2\frac{2}{7}$ in the length of the head. Eye somewhat nearer to the tip of the snout than to the first gill-slit, its longitudinal diameter $6\frac{2}{5}$ in the length of the head. Interorbital region flat with a slight median groove, its width $2\frac{3}{4}$ in the head. Spiracle subvertical, situated in a deep ovate rimmed pit, its diameter $\frac{2}{3}$ of that of the eye. Branchial region $2\frac{2}{5}$ times the diameter of the eye; width

of first gill-slit $\frac{3}{5}$ of the diameter of the eye and $\frac{5}{8}$ of that of the last slit. Length of head and trunk $\frac{4}{5}$ of that of the tail. First dorsal fin originating above the middle of the base of the ventral, its distance from the tip of the snout $2\frac{1}{4}$ in the total length; anterior and outer borders of fin sublinear, the intervening angle broadly rounded; posterior angle pointed, the hinder border proximally emarginate, its length $1\frac{1}{2}$ time the diameter of the eye and rather more than $\frac{1}{3}$ of its basal length, which is $1\frac{1}{2}$ time the vertical height of the fin: second dorsal similar to but not quite so large as the first, its distance from the origin of which is $1\frac{3}{4}$ in that from the tip of the tail. Distance between origin of anal and second dorsal less than the interval between the dorsals and $4\frac{5}{8}$ in its distance from the ventrals; its height is $2\frac{4}{5}$ in its base; free space between anal and caudal $1\frac{6}{7}$ in the base of the anal. Depth of lower caudal lobe $6\frac{1}{5}$ in its length, which is $4\frac{2}{7}$ in the total length, its extremity rounded; tip of vertebral column not nearly reaching the margin of the fin. Pectoral fin obovate, its distance from the ventral $\frac{2}{3}$ of that from the tip of the snout, its base rather more than $\frac{1}{2}$ of its greatest width and rather less than $\frac{1}{2}$ of its length, which is $\frac{6}{7}$ of that of the head. Origin of ventral fin a little nearer to the first dorsal than to the pectoral. A slight but distinct vertebral groove between the occiput and the first dorsal; lateral line strongly marked forming a ridge, connected by a transverse line above the spiracles. Upper surfaces, sides, and tail ashy gray; lower surface of head, throat, and abdomen white. (Named for my friend Mr. John Colclough, late of Brisbane, and now holding a responsible position in the Aru Islands).

Total length of type 460 millimeters.

Coast of Queensland.

Type in the collection of the Amateur Fishermen's Association of Queensland.

Described from an immature male caught at Mud Island, Moreton Bay, on June 8th, 1906, by Mr. F. L. Phillips, and presented by him to the above collection. Cat. No. 410.

There is a second specimen of about the same size in the State Museum.

DASYATIDÆ.

DASYATIS FLUVIORUM *sp. nov.*

Disk subcircular, its length $\frac{8}{9}$ of its width. Anterior borders of disk linear, meeting one another at a widely obtuse angle; posterior borders rather feebly, inner moderately convex; outer angles broadly, posterior somewhat narrowly rounded. Outer border of ventral fin nearly straight, as long as the snout; hinder border feebly convex, meeting the outer at rather less than a right angle, the point rounded; inner angle rounded. Width of mouth subequal to the space between the anterior angles of the nostrils. Snout slightly projecting beyond the anterior contour. Free border of nasal flap minutely fringed. Lower lip corrugated. Diameter of eye $2\frac{6}{7}$ in the width of the interorbital region, which is rather more than that of the mouth and $\frac{1}{8}$ of the length of the disk. Jaws undulated, the upper biemarginate, the intervening ridge fitting into the mesial emargination of the lower jaw, which is strongly bent backwards laterally, so that its entire posterior border is emarginate. Upper jaw succeeded by a wide, fimbriated, membranous flap, bearing on its free border 30 cilia. Floor of mouth with 7 papillæ arranged in three groups; on each side a pair, of which the inner is the longer, the outer sometimes absent or vestigial, and three in the middle, these being more conspicuous and truncated. No rostral groove; frontal region with a wide shallow tongue-shaped median depression, which is separated by a narrow bridge from a much smaller circular occipital depression. A row of small, open, mucigerous papillæ, mostly associated in pairs or threes, between the tip of the snout and the frontal depression, immediately in advance of which they form a small cluster; each preorbital region with a much larger group of similar papillæ, which extends backwards above and below the eye and is united to the rostral system by an oblique series of single pores; a small, irregular cluster outside of and partly anterior to the preorbital group; a semicircular series on either side of and a pair, placed transversely, within the occipital depression; a crescentic biserial band of subcutaneous tubular pores below and well outside the eye; a similarly situated oval cluster below

the spiracles. A group of small blunt tubercles above each spiracle, from which a more or less extended series curves forward along the supraciliary edge; a transverse row of three tubercles behind the occipital depression, from behind the middle one of which a series of retrorse spines extends along the dorsal ridge and is continued on the tail nearly to the base of the caudal spine; one of the median interscapular spines is slightly larger than the others of the vertebral series; entire scapular region tuberculigerous, the central group quinqueradiate, one branch directed forwards along and converging on the axial series, two directed outwards to a level with the spiracle, and two directed backwards, but somewhat divergent from the axis; on either side between the basal angles of the outer and hinder branches are two or three enlarged tubercles. Length of tail $2\frac{1}{4}$ times that of the disk; spinous tubercles of tail, especially the four nearest to the caudal spine, larger than those of the dorsal ridge; sides of tail with a few scattered prickles; proximal portion of caudal spine laterally granulated, the rest, with the exception of the extreme tip, which is smooth, armed with fine, closely set serræ; length of spine $\frac{5}{8}$ of that of the prespinous portion of the tail, which is $5\frac{1}{2}$ in the length of the tail. A short fold, highest posteriorly, on the upper surface of the tail, overlapped in front by the caudal spine; lower surface of tail with a much longer and slightly higher fold, which originates below the base of the caudal spine. Olive-brown above, the margins of the disk and the ventral fins lighter; below bluish white with the discal borders pale brown; tail black, the lower surface and sides of the proximal fourth brown; spine and tubercles whitish (*fluviorum*, of the rivers).

Measurements of type in millimeters.

Length from tip of snout to end of anus 250; width of disk 275; length of ventral fin along outer border 60; width of mouth 27; between outer anterior angles of nostrils 28; diameter of eye $10\frac{1}{2}$; width of interorbital region 30; length of tail 544.

Brisbane River, ascending well above the tideway.

This species is distinguished from *Dasyatis gymnura* (Müller)* by the shape of the snout, which in that species is "produced and sharp-pointed"; by the convexity of the posterior border of the disk; by the much shorter tail, which in *gymnura* is thrice the length of the disk; and by its general smoothness. In some respects it approaches *Dasyatis sabina* (Le Sueur), which is, like it, a strictly estuarine and fluviatile species.

EXOCŒTIDÆ.

EXONAUTES FULVIPES *sp. nov.*

D. 12; A. 12; Sc. 52—7. Depth of body 6, length of head $4\frac{4}{5}$ in the length of the body. Head a little wider than deep, its width equaling its length in front of the hinder margin of the eye. Snout $\frac{4}{5}$ of the diameter of the eye, which is $2\frac{4}{5}$ in the length of the head, $\frac{8}{9}$ of the postorbital region, and equal to the concave interorbital width. Gill-rakers 19 on the lower branch of the anterior arch, the last 3 tubercular, the longest $\frac{1}{3}$ of the diameter of the eye. Second pair of upper pharyngeal bones separate, armed with slender, conical, setaceous teeth; third pair fused, forming together a half-moon-shaped bone, which is densely clothed mesially with coarse scalpriform teeth, laterally with much smaller tricuspid teeth; lower pharyngeals united to form a sagittate bone, armed with small tricuspid teeth and a few somewhat enlarged and scalpriform teeth posteriorly.† Dorsal fin moderately high, its second and highest ray $\frac{1}{2}$, its basal length ^{4} of the length of the head: anal originating below the 2nd. ray of the dorsal, which also slightly overlaps it, its length $\frac{2}{3}$ of the head: upper

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* *Trygon gymnura* Müller, in Ermann, Reise um die Erde, p. 25, pl. xiii, 1830, is identical with *T. tuberculata* (not Bonnaterre 1788) Shaw, Gen. Zool., v, p. 290, 1804 (after Lacépède's Raie tuberculée) and Günther, Catal. Fish., viii, p. 480, 1870. The latter author records it from Sydney, confounding it with one of our eastern species, possibly my *D. thetidis*. (Mem. Austr. Mus., no. iv. pt. i, p. 46, 1899).

† There is abundant evidence to show that all the teeth were originally tricuspid, those which are now apparently chisel-shaped having had the cusps worn down by continuous trituration.

caudal lobe acutely, lower bluntly pointed, the latter $3\frac{1}{3}$ in the length of the body: two upper pectoral rays simple; 1st. ray $\frac{2}{3}$ of the 2nd, and $\frac{3}{8}$ of the 4th and longest ray; 2nd. ray $\frac{2}{3}$ of the 3rd, and $\frac{3}{5}$ of the 4th ray; outer branch of 3rd. ray extending to midway between the tips of the 2nd, and of its own inner branch; 3rd. ray of the 4th, which is $\frac{4}{5}$ of the length of the body and reaches to the base of the caudal: ventral inserted midway between the root of the caudal and the gill-opening; 3rd. ray longest, not quite reaching to the rudimentary caudal rays and $\frac{1}{3}$ of the body-length. Above glossy brown, each of the scales with a lighter border; sides of head and body golden brown; belly silvery: all the fins pale yellowish brown (*fulvus*, tawny; *pes*, foot).

Type in the Australian Museum, Sydney.

Total length 310 millimeters.

Seas round Lord Howe Island.

The specimen from which the above description was drawn up has been the subject of more than one examination and identification. Originally referred by me to the Middle American *Exonautes dowii*, Waite, during his visit to Lord Howe Island in December, 1902, having obtained several examples through the agency of certain complaisant nesting gannets, re-examined this specimen and decided that it belonged to the Atlantic* *E. rondeletii*; from this species, however, it differs among other characters, in its more slender form, longer snout, shorter anal fin (as compared with the dorsal), longer pectorals, posterior insertion, much greater length and uniform coloration of the ventrals. *E. fulvipes* is in fact the Western Pacific representative of the Atlantic *E. rondeletii*, while it is possible that the Eastern Pacific form, as exemplified by the Acapulco specimen, may differ specifically from both. No other known species of *Exonautes*, other than *E. exsiliens* and *E. rondeletii*, can possibly be confounded with

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* I am aware that Lütken records this species from Acapulco, a sea-port on the Pacific Coast of Mexico, but Lütken himself was in considerable doubt as to whether he was not confusing two or more species under the specific name *rondeletii*. "This species is subject to some variation, or else, as Dr. Lütken suggests, we are uncertain as to the number of real species that group themselves around its type." (Jordan & Evermann, Fish. N. & Mid. Amer., pt. i, p. 733, footnote*).

E. fulvipes, since all the others have the second pectoral ray divided.* *E. exsiliens* may easily be distinguished by the equality in length of the two first pectoral rays and the anterior position of the ventral fins, which are inserted midway between the root of the caudal and the eye.

Described from a fine specimen in the collection of the Australian Museum, Sydney; Reg. No. I. 1955. I have also examined a second specimen (unnumbered and without locality), labeled in Bleeker's handwriting "*Exocœtus exiliens*."†

Under the heading of "*Exocœtus unicolor* ? C. V."‡ Kner § records an exocœtid from Sydney; but we know from Bleeker's personal examination of the three examples upon which Valenciennes established his species, and which are part of the collection in the Jardin des Plantes, that this is a hybrid form composed of two specimens of *Cypsilurus* and one of *Exonautes*.

Bleeker's remarks on the three specimens mentioned by Valenciennes are as follows, and in my opinion form

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* I am unable to speak with certainty regarding *Exocœtus ilma* Clarke, as the author's long and rambling description gives but little clue as to its position, and the important characters connected with the upper pectoral rays are entirely omitted. Judging from the similarity of the dorsal and anal fins we believe it to be *Exonautes*.

† I take this opportunity of publicly thanking the Trustees and Curator of the Australian Museum for their kindness in lending me their valuable collection of flying-fishes.

‡ The following is a translation of Valenciennes' description:—

L'Exocet aux pectorales unicolóres.

(EXOCŒTUS UNICOLOR *nob.*

Another species from the Seas of India—

has the occiput flattened and the snout a little compressed, like that of the Mediterranean (*Exocœtus volitans*), but the eye is much larger and the head longer. The length of the head is somewhat less than $\frac{1}{5}$ of the total length (c.c.). The orbital diameter is $\frac{1}{3}$ of the length of the head The dorsal fin is low and nearly equal (in height).

D. 13; A. 11.

The color of the back, like that of the preceding species (*Exocœtus speculiger*) is uniform plumbeous; the pectorals are violaceous gray, without either the white spot or border of the preceding species. The ventrals are white, with a small gray longitudinal spot near the axil.

The specimens are a foot long; they have been brought from Vanikoro and Java by MM. Quoy and Gaimard; a third has come to us from the Seas of India by the courtesy of M. Dussumier.

§ Reise Novara, Fisch. p. 325.

the crux of the whole question :—" Formerly I believed that my *oligolepis* was identical with the *unicolor* of Valenciennes, but the examination which I was privileged to make in Paris, of the three examples which served Valenciennes for the establishment of his *unicolor*, has convinced me that not only is *oligolepis* very distinct from it, but also that *unicolor* is founded on three individuals which belong to at least two species, whilst it is not mentioned in the description from which of the three that has been taken. All three specimens have about 50 scales in a longitudinal series, which proves that it cannot rationally be confounded with *oligolepis*. In the individuals from Vanikoro and the Seas of India *the dorsal fin commences well in advance of the anal* and is composed of 13 rays, and I presume that it is from these examples that the description has been taken. These then should constitute the true *unicolor*. As for Valenciennes' third example, which came from Java, it is a very distinct species, with *the dorsal fin originating opposite the first anal ray* and supported by 10 rays only. This individual appears to me to be indistinguishable from *Exocœtus oxycephalus* Bleeker, Valenciennes having failed to recognise it as a distinct species."* The italics in the above paragraph respecting the origin of the dorsal fin are mine.

The above quotation fixes without fear of contradiction the *Exocœtus unicolor* of Valenciennes as a *Cypsilurus*, firstly because the dorsal formula of 13 rays given by that author belongs (fide Bleeker) to the two specimens in which " the dorsal fin commences well in advance of the anal," secondly because Bleeker was the earliest author to fix the name *unicolor* on a definite specimen, and thirdly when two of three examples have been proved to belong to a particular genus we would naturally take one of the majority as the type of the species in preference to the single example forming the minority, no type specimen having been designated by the author ; and more especially in this case where the arbitrary selection of such a type would wilfully flout the author's own determination as regards the number of the dorsal rays. Valenciennes' species should, therefore, be included in the genus *Cypsilurus*,

* Atlas Ichth., vi, p. 70.

taking, for choice, the Vanikoro fish as the type, that being the first specimen referred to by its describer.

In Professor Jordan's recent great work* this fish is twice referred to as *Exonautes unicolor*, but the above remarks in my opinion clearly prove that this view of its generic position is founded on error. In vol. I, p. 341, an Australian flying-fish is figured with the legend, "Australian Flying-Fish, *Exonautes unicolor* (Valenciennes). Specimen from Tasman Sea, having parasitic lernæan crustaceans, to which parasitic barnacles are attached (After Kellogg)." The second quotation, in vol. II, p. 213, is—"The large Australian species *Exonautes unicolor* belongs to this group." The undivided second pectoral ray in Kellogg's figure certainly suggests that it belongs to the species here described, but the fin formula—D. 10, A. 12 —together with the overlapping of the dorsal by the anal, and the extraordinary shape of the latter fin, points to quite a distinct fish; the origin of the anal being distinctly behind that of the dorsal it can not be Valenciennes' Javan fish in which both fins commence on the same plane, and in which the second pectoral ray is divided (equals *Exocœtus oxycephalus* Bleeker). Taking all things into consideration, I am inclined to believe that the figure is intended to represent *Exonautes fulvipes*, which, however, can not strictly be called "the large Australian flying-fish," since, so far as is known, the limit of its growth is about one foot, while *Cypsilurus melanocercus*, which inhabits much the same area, and which is the Pacific representative of *Cypsilurus lineatus*, attains a length of eighteen inches.

Before concluding this article there is just one other point to be cleared up, and that is the identity of the Sydney flying-fish referred with a query by Kner to *Exocœtus unicolor*. There are several features even in his insufficient description which do not agree with the two specimens on which my diagnosis is founded. For instance, there is one ray less in the dorsal and anal fins, the smaller eye is more than the interorbital width, which is flat, and the pectorals are shorter; while of course we know nothing of the pectoral formula in Kner's fish. Should, however, Kner's fish eventually prove to be identical with that described above,

* A Guide to the Study of Fishes by David Starr Jordan, 1905.

which can only be ascertained by a direct comparison of the Sydney fish with my description*, the specific name *fulvipes* would be superseded by *cribrosus* Kner, an alternative name given by that author to his fish, and in that case the synonymy of the species would stand as follows :—

EXONAUTES CRIBROSUS.

Exocœtus unicolor ? C.V. ; Kner, Reise Novara, Fische p. 325, 1867 : Sydney.

Exocœtus cribrosus Kner, ibid., p. 326. Suggested new name should the species prove distinct from *E. unicolor*.

Exocœtus dovii Ogilby, Mem. Austr. Mus., No. 2, Lord Howe Island, p. 71, 1889. Not *E. dowii* Gill, 1863 = *E. rufipinnis* Cuvier & Valenciennes, 1846.

Exonautes rondeletii Waite, Rec. Austr. Mus., v, 1904, pp. 156 & 195 : Admiralty Islets. Not *Exocœtus rondeletii* Cuvier & Valenciennes, 1846.

Exonautes unicolor Jordan, Study of Fishes, i, fig. 226 & ii, p. 213, 1905. Not *Exocœtus unicolor* Cuvier & Valenciennes, 1846, which is a *Cypsilurus*.

Exonautes fulvipes Ogilby. Supra.

PTENONOTUS *gen. nov.*

This genus is proposed for the accommodation of *Exocœtus cirriger* Peters,† and differs from *Cypsilurus* and *Exonautes*, between which it should be placed, in the elongated hemirhamphiform body, the permanency of the submental appendage, which is of great size and divided distally into numerous fine cutaneous filaments, and in the high, pointed dorsal fin, which extends, when depressed, far beyond the base of the caudal. (πτηνός, winged ; νῶτος, back.)

Hab. China Sea.

* If, as I presume, Kner's Novara specimen from Sydney is deposited in the collection of the Imperial Museum, Vienna, Dr. Steindachner might set at rest for ever the identity of *Exonautes cribrosus* by making the suggested comparison.

† Mon. Akad. Berlin, 1877, p. 555.

CARANGIDÆ.

TRACHINOTUS VELOX *sp. nov.*

D. vi, i 25 ; A. ii, i 26 ; Sc. 100 circ. Depth of body $2\frac{3}{5}$, length of head $3\frac{2}{3}$ in the length of the body. Dorsal profile a little more arched than the ventral ; profile of head slightly convex from behind the feebly declivous snout to the nape, thence obliquely linear to the origin of the dorsal fin. Snout as long as the diameter of the eye, which is $3\frac{1}{2}$ in the length of the head ; interorbital width rather more than the diameter of the eye. Jaws equal ; maxillary reaching to below the anterior border of the pupil, its width at the distal extremity $\frac{1}{3}$ of the eye. Jaws with a narrow band of villiform teeth, the outer series slightly enlarged ; vomer with a triangular patch, palatines each with a short band of similar teeth. Cheeks and upper third of opercles scaly ; anterior half of lateral line undulating and slightly descending ; posterior half straight. Anterior rays of the dorsal fin extending to the tip of the last ray, of the anal fin to the base of the caudal, the former $1\frac{6}{7}$, the latter $1\frac{3}{5}$ in the length of the body : upper lobe of caudal fin considerably longer than the lower lobe and a little longer than the produced anal rays : pectoral fin just reaching to the vertical from the vent, $\frac{5}{7}$ of the length of the head : ventral reaching $\frac{8}{9}$ of its distance from the vent, its length $\frac{3}{7}$ of the head. Bluish gray above, silvery on the sides and below ; a series of from five to seven more or less conspicuous bluish spots above but usually touching and anteriorly sometimes even encroaching upon the lateral line : elongate rays of the dorsal and anal, and the outer rays and tips of the caudal lobes dark leaden blue (*velox*, swift).

Type in the collection of the Amateur Fishermen's Association of Queensland ; Cat. No. 289.

By previous writers on Australian zoology this very distinct species has been confounded with the Indian *Trachinotus russellii*, the confusion having doubtless arisen through the similarity of the color markings in the two species. The western fish may, however, be easily distinguished by its deeper body ($2\frac{1}{4}$ in the length) ; by the shortness of the dorsal and anal lobes, which do not extend to the end of their respective bases, and of which the dorsal

lobe is the longer; by the much shorter caudal lobes ($2\frac{3}{4}$ in the length); by the more forward insertion of the ventral fin (below the base of the pectoral); etc. Up to the present we have no authentic knowledge of the occurence of either *T. russellii* or *T. baillonii*, which are certainly distinct. in the seas of the Commonwealth, and all records of these two species eastward from a line drawn between the West Coast of Australia and the Moluccas must be looked upon with grave suspicion.

Described from a half grown example, caught in the South Passage, Moreton Bay, and presented to the A.F.A.Q. Museum by Mr. Willie J. Howes.

FAMILY APOGONIDÆ.

APOGONICHTHYS NEBULOSUS *sp. nov.*

D. vi, i 9; A. iii 8; Sc. 25 circ.; L. l. 9. Depth of body $2\frac{2}{3}$, length of head $2\frac{3}{8}$ in length ot body. Snout $\frac{1}{3}$ longer than diameter of eye, which is $\frac{1}{4}$ of length of head. Interorbital region convex, its width $5\frac{3}{8}$ in the head. Maxillary extending to below middle of eye, the width of its distal extremity $\frac{5}{8}$ of the eye; lower jaw the longer. Lateral line ceasing below the spinous dorsal. Spinous dorsal originating behind base of pectoral; second spine highest, $2\frac{1}{4}$ in length of head and not quite so high as the soft dorsal: anal originating slightly behind and somewhat higher than soft dorsal, its basal length $3\frac{1}{6}$ in the head: caudal rounded, $3\frac{3}{5}$ in length of body: pectoral $\frac{3}{5}$ of length of head and as long as the ventral, which reaches to the vent. Pale greenish gray, marbled with olive green; upper surface of head darker; a pair of short, broad, posteriorly convergent, brown bands on the occiput: tips of anal and ventral fins dusky. Irides silvery, strongly suffused with umber brown. (*nebulosus*, clouded).

Dimensions of type in millimeters.—Total length to end of middle caudal ray 57; to end of hypural bone 45; depth of body 17·5; length of head 19; of snout 6·25; diameter of eye 4·75; width of interorbital region 3·5; of maxilla 3; height of 2nd dorsal spine 8·5; of soft dorsal 9·5; length of anal 6; height of anal 10; length of caudal 12·5; of pectoral 12; of ventral 12.

Type in the collection of the Amateur Fishermen's Association of Queensland.

Distribution.—Brisbane River. Type locality, Edward Street Baths.

FAMILY SERRANIDÆ.

HYPOPLECTRODES JAMESONI *sp. nov.*

D. x 20; A. iii 8; Sc. 3—$\frac{43}{36}$—14; L. l. 40. Depth of body $2\frac{1}{2}$. length of head $2\frac{2}{5}$ in length of body. Snout $\frac{2}{5}$ longer than diameter of eye, which is $4\frac{3}{4}$ in length of head. Interorbital region flat, its width about $\frac{1}{9}$ of length of head. Maxillary extending to below middle of eye, the width of its distal extremity $\frac{5}{6}$ of the eye; lower jaw the longer. Preopercle with 3 strong antrorse spines on the lower border; subopercle denticulated; upper opercular spine much the longer. Scales of cheeks, opercles, nape, and breast much smaller than those of the body; lateral line tubes simple, short anteriorly but gradually increasing in length so that posteriorly they extend nearly along the entire scale. Dorsal originating in advance of base of pectoral; 5th. dorsal spine highest, $2\frac{3}{5}$ in length of head and a little more than the highest soft rays; 10th. spine nearly as high as the 2nd. $\frac{2}{3}$ of highest soft rays: 2nd. anal spine very strong, higher than the 3rd, and than the highest dorsal spine, the rays about as high as the 2nd. spine: caudal truncate, $4\frac{2}{3}$ in total length: pectoral with 16 rays, $\frac{3}{4}$ of length of head and longer than the ventral, which just reaches the vent. Dark olive brown above the lateral line, the trunk and tail with about nine narrow gray bands, which are inconspicious anteriorly; below the lateral line the gray predominates the dark markings taking the form of seven or eight irregular, transverse, slightly oblique bands, any two of which may be wholly or partially connected, and which only become annular on the tail: sides of head with three longitudinal series of brown spots, the first from below the eye to the preopercular border, whence it curves upwards behind the eye; the second from the maxilla to the middle of the base of the pectoral; the third from the angle of the mouth to below the same; chin blackish; a black band behind the chin and a pair of similar spots below the corners of the mouth; opercles

marbled. Spinous dorsal and basal half of soft similar to the back; outer half of soft dorsal and of caudal lighter with a distinct reddish tinge; anal violaceous gray, with two dark basal spots; pectorals strongly, ventrals faintly tinged with red. Irides dark purplish brown. (Named for Mr. Jonathan Thompson Jameson, an enthusiastic collector, who has brought me many interesting zoological specimens.)*

Dimensions of type in millimeters.—Total length to end of middle caudal ray 85; to end of hypural bone 70; depth of body 28; length of head 29; of snout 8·5; diameter of eye 6; width of interorbital region 3·25; of maxilla 5; height of 5th dorsal spine 11; of 2nd anal spine 12·5; length of caudal 15; of pectoral 21; of ventral 18.

Distribution.—Moreton Bay. Type locality, Woody Point; other specimens seen from Sandgate.

This very distinct species belongs to the *Gilbertia* group of *Hypoplectrodes*, and is most nearly related to *H. semicincta*, from which, however, the much larger scales and more strongly developed anal fin at once distinguish it. The pattern of coloration also is widely different from that of the other members of the genus.

PARAPLESIOPS POWERI.

D. xii 10; A. iii 10. Sc. 2—33—12; L. l. $\frac{30}{12}$. Depth of body equal to the length of the head, which is $\frac{1}{3}$ of that of the body. Snout short and rounded, $\frac{7}{10}$ of the diameter of the eye, which is $\frac{1}{3}$ of the length of the head. Interorbital region narrow and feebly convex, its width $5\frac{3}{4}$ in the head. Jaws equal; maxillary extending to below the hinder border of the eye, the width of its distal extremity $\frac{5}{9}$ of the diameter of the eye. Angle of preopercle with several stout spines. Several series of small scales on the cheeks and postorbital region; opercular scales large. Gill-rakers 12 on the lower branch of the anterior arch. Last dorsal spine the highest, $1\frac{9}{10}$ in the length of the head and $2\frac{1}{4}$ in the 6th and highest ray: 3rd anal spine the highest, as high as the last dorsal spine, the 6th soft ray as high

* I am the more pleased at this opportunity of naming so handsome a species after my friend Mr. Jameson, because it was through my instrumentality that the supposed species named by Macleay *Atherinosoma jamesoni* was reduced to a synonym of *Pseudomugil signifer*.

as the highest dorsal ray and $2\frac{1}{2}$ in the length of the body, as also is the pointed caudal fin: pectoral with 18 rays, the middle the longest, extending to the vertical from the origin of the anal and a little longer than the head: ventral reaching to the base of the first soft anal ray, $2\frac{1}{4}$ in the length of the body. Uniform greenish brown, the upper surface and sides of the head with a purplish gloss: all the fins blackish, except the pectorals and basal third of the ventrals, which are pale yellowish brown.

The description is taken from a fine example, 172 millimeters in length, caught at Mud Island, Moreton Bay, by Mr. Percy Power, to whom I have great pleasure in dedicating this handsome and very distinct species, which he kindly presented to the collection of the Amateur Fishermen's Association of Queensland. Cat. No. 224.

OPISTOGNATHIDÆ.

MEROGYMNUS *gen. nov.*

Differs from *Gnathypops* in having the greater part of the trunk naked, the teeth subequal in size, without any conspicuously enlarged series, and the gill-rakers more numerous, longer, and slender (*μέρος*, in part; *γυμνός*, naked);

East Coast of Australia. Two species.

MEROGYMNUS EXIMIUS *sp. nov.*

D. xi 13; A. i 12; Sc. 85 circ.* Width of body $7\frac{1}{5}$, depth of body $3\frac{3}{4}$, length of head $2\frac{9}{10}$ in the length of the body. Width of head $\frac{3}{4}$ of its depth and $\frac{5}{9}$ of its length. Length of snout $\frac{4}{7}$, interorbital width $\frac{2}{7}$ of the diameter of the eye, which is $3\frac{1}{5}$ in the head. Maxillary extending less than a diameter of the eye behind the eye, its length $\frac{2}{3}$ of that of the head, the width of its distal extremity $\frac{5}{9}$ of the eye. Jaws with broad bands of small subequal curved teeth; one or two teeth on the vomer. Nasal tentacle minute. Gill-rakers 26 on the lower branch of the anterior arch, the longest $\frac{4}{5}$ of the snout. Anterior half of the trunk naked, the rest of the body covered with minute scales,

* Between the base of the caudal fin and the vertical from the vent, in front of which they are mostly irregular, non-imbricate, and deeply imbedded.

which become increasingly distant and imbedded towards the front; lateral line ceasing below the 5th or 6th dorsal ray. Dorsal fin originating above the middle of the opercle, the length of the spinous portion but little less than that of the soft; height of the last dorsal spine about $\frac{2}{3}$ of that of the longest (8th or 9th) dorsal ray, which is $\frac{4}{7}$ of the head: anal originating below or but little behind the commencement of the soft dorsal and about as long as it: caudal long, its length $\frac{1}{4}$ or rather more, that of the pectoral $\frac{1}{6}$ of the length of the body: ventral produced, nearly reaching to the vent, $\frac{2}{3}$ of the length of the head. Golden or golden brown, the sides and lower surface of the tail with two series of large round or oval, golden spots, separated by broad blue interlacing bands; abdominal region and end of tail violet, with splashes of greenish gold: head lilaceous, with irregular violet spots and bars; a deep blue blotch, prolonged upwards as a zig-zag violet band on the opercle; branchiostegal region blackish: outer half of spinous dorsal dark olive green, narrowly bordered above with purple, below with pale blue; the latter band is continued to the end of the soft dorsal, the outer half of which is pale olive green with many of the membranes blue, as also is the base; anal blue, with a median and a basal series of golden spots; caudal rays olive green or purple, the interradial membrane blue; pectorals pale yellowish brown, the base with one or two vertical blue bars; ventrals bluish black. Iris light blue, with a narrow golden brown rim; pupil dark blue (*eximius*, beautiful).

Type in the collection of the Amateur Fishermen's Association of Queensland; Cat. No. 320. Presented to the Museum by Mr. J. Stitt.

Total length 285 millimeters.

Snapper Banks off Moreton Bay, Queensland.

FAMILY MULLIDÆ.

PSEUDUPENEUS JEFFI *sp. nov.*

D. viii, i 8; A. ii 6; Sc. $2\frac{1}{2}$—$28+3$*—$6\frac{1}{2}$. Depth of body $3\frac{1}{2}$, length of head $3\frac{1}{5}$ in length of body. Diameter of eye equal to width of rounded interorbital region and $\frac{5}{8}$ of snout, which is $2\frac{1}{5}$ in head and is deeply grooved trans-

* On the base of the caudal.

versely above the anterior nostril, from whence the head rises rather abruptly. Teeth stout and conical, in a single series in both jaws. Maxillary extending to midway between anterior nostril and eye, the width of its distal extremity $\frac{5}{8}$ of the latter; lower jaw included; barbels extending to below posterior border of pupil. Opercular spine conspicuous. Cheek-scales in three series; 2 complete scales between the dorsal fins; tubes of lateral line with from 3 to 5 tubules, mostly on the upper side.* Spinous dorsal originating above base of pectoral, shorter† but higher than soft dorsal; 3rd spine highest, $\frac{4}{7}$ of head: middle caudal rays $\frac{1}{2}$ of the outer, which are $\frac{4}{5}$ of head; caudal peduncle rather slender, its least depth $\frac{3}{5}$ of its length and $\frac{6}{7}$ of that of snout: pectoral with 17 rays, reaching to 11th scale of lateral line, and a little shorter than ventral, which is $\frac{4}{5}$ of head. Reddish, the median line of the back darker; two broad curved bands on the upper half of the sides greenish yellow; below them a third narrower linear yellow band; these bands extend forwards to the snout and maxillary, the upper passing through the eye and uniting with the dorsal band behind the soft fin, the median terminating at the base of the caudal fin, the lower above the end of the anal; these bands are separated by narrow bars of shining pink; lower surface pearly white; a dark spot on the upper lateral band close behind the eye, and a second at the angle of the preopercle, the two connected by a lighter band; a larger black blotch on each side of of the upper half of the caudal peduncle, united above by a broad brown band. Fins red, the proximal half of the rays paler; soft dorsal and caudal narrowly tipped with yellow; base of pectorals dark reddish brown; ventrals with or without a golden submarginal band. Irides fiery orange, clouded above with olive. (Named for Mr. Vincent Henry Jeff. a most generous donor to our Museums).‡

Total length of type to end of middle caudal rays, 121 millimeters.

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* As is often the case some of the posterior tubes may be simple; in this instance 5 on the right side are simple while all on the left are branched.

† Membrane of terminal spine not included.

‡ Mr. Jeff's numerous and valuable donations, both to the State Museum and to that with which I am specially associated, entitle him to the warmest thanks of all who are interested in our marine zoology.

Type locality: Brisbane River.

Jeff's Red Mullet is closely related to *Upeneus signatus*, Günther, but the pattern of coloration is so widely different that I deem it better to call attention to it thus, more especially as Günther's species has never been recorded from this State, nor in fact, further north than the Port Jackson District, where it is common.

Nine species of "red mullets" have up to the present been recorded from the Queensland Coast, but this number will doubtless be largely augmented when our northern waters shall have been more critically exploited, since at least ten other Indo-Malayan forms have already been noticed from British New Guinea, the Solomon Islands, and the New Hebrides, namely:—*Upeneus sulphureus*, *Mulloides ruber*, *Pseudupeneus cherserydrus*, *P. filamentosus*, *P. barberinoides*, *P. indicus*, *P. malabaricus*, *P. bifasciatus*, *P. trifasciatus*, and *P. pleurostigma*.

Our recorded species are as follow:—

i. UPENEUS Cuvier, Règne Anim., ed. 2, ii, p. 157, 1829 (*vittatus*).

Bands of villiform teeth in both jaws, on the vomer and the palatines.

1. *vittatus* Forskål, Descr. Anim., p. 31, 1775.
2. *tragula* Richardson, Ichth. China & Japan, p. 220, 1846.
3. *roseus* Castelnau, Res. Fish. Austr., p. 11, 1875.

ii. MULLOIDES Bleeker, Nat. Tijds. Ned. Ind., iii, 1852, p. 697 (*flavolineatus* = *auriflamma*).

Bands of villiform teeth in both jaws; vomer and palatines toothless.

4. *auriflamma* Forskål, ibid., p. 30.
5. *armatus* de Vis, Proc. Linn. Soc. N. S. Wales, ix, 1884, p. 458 (? *samoensis*).

iii. PSEUDUPENEUS Bleeker, Mem. Poiss. Cote de Guinée, p. 56, 1862 (*prayensis*).

A single series of stout conical teeth in each jaw; vomer and palatines toothless.

6. *barberinus* Lacepede, Hist. Nat. Poiss., iii, p. 406, 1802.
7. *rubroniger* de Vis, ibid.
8. *jeffi* Ogilby, ut supra.
9. *porosus* Cuvier & Valenciennes, Hist. Nat. Poiss., iii, p. 455, 1829.

FAMILY TETRAODONTIDÆ.

SPHEROIDES PERLEVIS *sp. nov.*

D. 8; A. 6; P. 16. Body robust, evenly tapering from behind the eye, its depth $3\frac{3}{5}$, length of head 3 in length of body. Width of head $1\frac{1}{6}$, depth of head $1\frac{1}{5}$ in its length. Eye moderate, free below, its diameter $2\frac{1}{3}$ in length of snout and $4\frac{3}{4}$ in that of head. Interorbital region feebly convex, its width $7\frac{4}{5}$ (including eyelids $2\frac{1}{6}$) in the head. Lips equal, papillose within; lower jaw included; chin prominent. Teeth with slightly uneven edges and well marked sutural grooves. Width of gill-opening $\frac{2}{5}$ more than diameter of eye, its inner fold slightly protruding upon the inferior half. Skin entirely free from spinules, everywhere longitudinally striated; lateral ridge strongly developed, but less conspicuous on head and distal end of peduncle. Lateral line gently curved and slightly undulating to a point midway between tip of pectoral and origin of dorsal where it descends more abruptly; thence nearly straight to base of caudal; a transverse line, divided mesially, above base of pectoral; a short branch curving behind the eye; another between hinder margin of eye and lateral ridge; main line carried forward from below hinder third of lower eyelid in a wide curve to the nostril; a short disconnected line, divided mesially, in front of nostril; a second line below lateral ridge from extremity of pectoral to base of caudal. Dorsal fin pointed, its length $2\frac{1}{2}$ in its height, which is 2 in the head, its distance from the caudal $3\frac{2}{5}$ in total length: anal fin originating below the middle of, shorter and lower than. the dorsal: caudal fin feebly rounded, $4\frac{3}{4}$ in total length; depth of caudal peduncle immediately behind base of dorsal $\frac{4}{5}$ of its width at the same place, its least depth $4\frac{2}{3}$ in the head: pectoral fin rounded, with the upper angle slightly produced, $1\frac{7}{8}$ in length of head. Upper surface lilaceous brown, mottled with gray, and closely dotted and lined with darker brown; lower half of sides gray with larger violet spots; below pearly white; an irregularly oblong, narrow, silvery ring in front of the dorsal.* Dorsal and caudal fins violaceous; anal and pectorals whitish. Iris golden. (*perlevis*, very smooth: in reference to the complete absence of dermal spinules).

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* Perhaps an individual peculiarity.

Type in the collection of the Amateur Fishermen's Association of Queensland, to which it was presented by Mr. Chris. Dahl, who caught it at Sandgate, Moreton Bay.

Finally, I have much pleasure in recording the following fishes, examples of which are in the collection of the Amateur Fishermen's Association, as new either to the Commonwealth or to the State Fauna.

To the Australian fauna should now be added—

Paraplotosus albilabris Cuvier & Valenciennes, Hist. Nat. Poiss., xv, p. 427, 1840: Batavia. A single specimen from Dunk Island; E. J. Banfield; Cat. No. 469.

Sphyræna brachygnathos Bleeker, Nat. Tijds. Ned. Ind., vii, 1854, p. 368: Batchian. Occurs in Moreton Bay; Chris. Dahl; Cat. No. 439.

Apogon endekatænia Bleeker, ibid., iii, 1852, p. 449: Banka. Several specimens from Green Island (Cairns District) and Dunk Island, collected respectively by Messrs. E. J. Lyons and E. J. Banfield; Cat. Nos. 198 & 472.

Apogon macropterus Kuhl & van Hasselt: Cuvier & Valenciennes, ibid., ii, p. 160, 1828: Java. A single specimen from Dunk Island; E. J. Banfield; Cat. No. 474.

Stethojulis renardi Bleeker, ibid., ii, 1851, p. 253: Banda. Two specimens, one from Green Island, Cairns, E. J. Lyons, and one from Dunk Island, E. J. Banfield; Cat. Nos. 199 & 485.

Teuthis nigrofuscus Forskal, Descr. Anim., p. 64, 1775: Djidda. One specimen from Dunk Island; E. J. Banfield; Cat. No. 481.

Pterois lunulata Schlegel, Faun. Japon., Pisc. p. 46, 1843: Nagasaki. One specimen from Mooloolah; J. H. Stevens; Cat. No. 421.

Addenda to the Queensland fauna.

Galeus australis Macleay, Proc. Linn. Soc. N. S. Wales, vi, 1881, p. 354: Port Jackson. I have examined two specimens of this shark from Moreton Bay. The most northerly locality previously reported was "off Morna Point to the south of Port Stephens" (Waite, Mem. Austr. Mus).

Engraulis antipodum Günther, B. M. Catal. Fish., vii, p. 386, 1868: Tasmania and New Zealand. Visits our

southern shores in large shoals during the winter months. Southport, J. Douglas Ogilby; Cat. No. 686.

Hyperlophus copii Ogilby, Proc. Linn. Soc. N. S. Wales, xxii, 1897, p. 72: Maroubra. Same as preceding. Mud Island; J. Douglas Ogilby; Cat. No. 413.

Aulopus purpurissatus Richardson, Icon. Pisc., p. vi, pl. iii, fig 3, 1843. Occasionally taken on the Snapper Grounds off Moreton Bay, and ranging northward to Laguna Bay, Tewantin, whence I received a specimen through the courtesy of Mr. V. H. Jeff; Cat. No. 156. Also one from Mount Tempest; C. Russell; Cat. No. 339.

Thunnus thynnus (Linnæus), Syst. Nat., ed. 10, p. 297, 1758. I have examined two specimens of *Thunnus*, the first taken in Port Jackson, the second in Moreton Bay, and was unable in either case to find any characters by which they might be differentiated from the Mediterranean fish.

Trachurus declivis Jenyns, Zool. Beagle, iii, Fish. p. 68, 1842: King George's Sound. Visits our coast during the winter months. Cape Moreton; C. Sigley; Cat. No. 95.

Apogon roseigaster Ramsay & Ogilby, Proc. Linn. Soc. N. S. Wales, xi, 1887, p. 1101: Port Jackson. Abundant in the Brisbane River.

Apogonichthys auritus Cuvier & Valenciennes, Hist. Nat. Poiss., vii, p. 443, 1831: Mauritius. Two examples; Dunk Island; E. J. Banfield; Cat. No. 473: One example; Bell's Swamps, in fresh water; W. Weatherill.

Acanthistius serratus Cuvier & Valenciennes, ibid., ii, p. 399, 1828: King George's Sound. Two examples; Point Lookout; E. H. Shearwin; Cat. No. 425.

Chilodactylus fuscus Castelnau, Proc. Linn. Soc. N. S. Wales, iii, 1879, p. 376: Port Jackson. One specimen; Moreton Bay; V. H. Jeff; Cat. No. 172.

Verreo oxycephalus Bleeker, Notices Ichth., p. 7, 1862: Japan. One example; Arkwright Shoal; H. W. Haseler; Cat. No. 269.

Achœrodus badius Ogilby, Edib. Fish & Crust. N. S. Wales, p. 134, 1893: Port Jackson. Not uncommon in the shop windows during the winter of 1906; not observed during that of 1907; again common in 1908.

Platyglossus immaculatus Macleay, Proc. Linn. Soc. N. S. Wales, ii, 1878, p. 363: Port Darwin. One specimen; Dunk Island; E. J. Banfield; Cat. No. 484.

Pseudolabrus gymnogenis Günther, ibid., iv, p. 117, 1862: Port Jackson. One specimen; Mooloolah; C. Sigley & H. W. Haseler; Cat. No. 178.

Pseudolabrus nigromarginatus Macleay, ibid., iii, 1878, p. 35: Port Jackson. One specimen; Caloundra Banks; W. H. Sidle; Cat. No. 158.

Olisthops cyanomelas Richardson, Ann. & Mag. Nat. Hist. (2) vii, 1851, p. 291: King George's Sound. One specimen; Southport; H. Myers; Cat. No. 568.

Cæsiosoma æquipinnis Richardson, Zool. Erebus & Terror, Fish. p. 121, 1848: King George's Sound. Not uncommon on the Snapper Banks off Moreton Bay, but apparently not found inshore as is its habit further south.

Atypichthys strigatus Günther, ibid., ii, p. 64, 1860: Swan River. Large examples are occasionally taken in the same localities as the preceding species.

Parachætodon ocellatus Cuvier & Valenciennes, ibid., vii, p. 229, 1831: loc. ign. One specimen; Morteon Bay; Miss Gwendoline Fitzgerald; Cat. No. 446.

Pseudorhombus novæ-cambriæ Ogilby, Proc. Linn. Soc. N. S. Wales, xxiii, 1898, p. 296: Port Jackson. Not uncommon in Moreton Bay.

Aserragodes macleayanus Ramsay, Proc. Linn. Soc. N. S. Wales, v, 1881, p. 462: Port Jackson. I have seen specimens from the Brisbane River and trawled a pair off Caloundra.

Synaptura nigra Macleay, ibid., vi, 1881, p. 49: Port Jackson. Not uncommon in our southern estuaries.

Addenda to the New South Wales fauna—

Spilotichthys labiosus Macleay, Proc. Linn. Soc. N. S. Wales, viii, 1884, p. 202: Wide Bay. Occurs at least as far south as the Tweed Heads.

In addition to the above, I provisionally refer to *Odontaspis tricuspidatus* Day (Fishes of India, p. 713, pl. clxxxvi, fig. 1, 1878: Karachi), a pair of large sharks captured in my presence some years ago on the coast of New South Wales in the course of a visit of inspection to the Manning River oyster beds by the late Hon. J. Want, Dr. James Cox, and others. Day's description agrees fairly well with my notes taken from the specimens in

question, except in respect to color, mine being of a dark steel blue above, whereas Day describes his as being " brown superiorly." The original specimens came from the coasts of Sind and Beluchistan, but Day mentions one in the British Museum from South Australia. They attain a length of twenty feet.

Note a :—In September, 1906, I received from Mr. T. F. B. Mullin the jaws of a shark captured in Table Bay by one of his employees, who had recently arrived from South Africa, having sailed direct from Capetown to Brisbane. On examination these proved to belong to a cestraciont shark belonging to the *Heterodontus philippi* group. As I am unaware that the family *Heterodontidæ* has as yet been recorded from the seas of the Cape,* and as it is extremely unlikely that the Australian species should range so far westward, I propose to distinguish the South African form as *Heterodontus bonæ-spei*.

Note b. :—Mr. J. T. Jamison, of Woody Point, having kindly obtained for me some of the fishes on which Macleay founded his *Atherinosoma jamesoni*† I am reluctantly obliged to announce their identity with *Pseudomugil signifer*, Kner.‡

* Shortly after receiving the specimen I wrote to the Curator of the South African Museum on the subject but have not as yet received an answer; 23rd June, 1908.

† Proc. Linn. Soc. N. S. Wales, ix, 1884, p. 171 : Bremer River.

‡ Reise Novara, Fisch. p. 275, pl. xiii, fig. 5, 1867 : Sydney.

THE GLASSHOUSE MOUNTAINS.

By JOHN SHIRLEY, B. Sc.

DISTRICT INSPECTOR OF SCHOOLS.

A Paper read before the Royal Society of Queensland on April 27th, 1907.

THE Glasshouse Mountains were discovered by Captain Cook in May, 1770, during his first voyage to southern seas. They were so named from their resemblance, at a distance, to the glass furnaces or glass houses with which Cook was so familiar in Northern England. They were sighted by Flinders in July, 1802, and are mentioned in his "Voyage to Terra Australis in H.M.S. The Investigator."

Mr. Stutchbury, who visited the Caboolture district in August, 1854, gives the following description of these strange peaks :—The special forms and characteristics which the Glasshouse Mountains present are peculiarly interesting. At first sight, hand specimens might be taken for a fine grained granite ; but on examining these *en masse* and carefully viewing all the attendant circumstances, there can be no doubt that they are metamorphic sandstones. It is evident that no granite masses could have been projected in the form they now assume ; they must have been surrounded by some supporting material such as the continuation or extension of the same strata would give, now removed by denudation. Upon careful examination, lines of stratification can yet be traced. The largest of these mountains, "Beerwah," presents precipitous faces, especially on the northern and eastern faces, exhibiting semi-basaltic columns leaning from the base towards the centre." "We can easily imagine that at a period subsequent to the coal measures there were as many foci of heat as there are now mountains."

The last part of Mr. Stutchbury's statement should have given him the clue to the formation of these remarkable mountains. He tried to account for their formation as masses of plutonic rocks, as igneous rocks which had crystallized at depths, and failed. If he had tried to account for them as volcanic rocks, he would have been more successful. He recognized that "there were as many foci of heat as there are now mountains," but he went no farther. The simplest explanation of their origin is that each marks the site of a volcano, once standing as a truncated cone, its sides built up of alternate layers of tuff and lava, and having a crater at its blunt apex. Below the crater and piercing the central axis of the mountain was the pipe up which molten matter made its exit at each volcanic outburst. After the last explosion, this pipe was filled with a plug of solidified lava that formed the hardest rock of the mountain. By denudation through successive ages all the softer parts of these volcanoes have been swept away. The slopes of tuff, or volcanic ash, and lava have gone, the crater has gone; except in the case of Crookneck or Coonowrin nothing is left but the plug of volcanic rock which filled the volcanic vent. Even this is now suffering denudation in turn. Round the base of each mountain is a talus of blocks, detached from its surface by the action of frost, running water and the daily variations of temperature. With one exception, they rise baldly from the coast plain on which they stand. This exception is Crookneck, which has as its base a small collar of Trias-Jura rocks.

The continuous rains of the first quarter of 1893 brought about an immense landship on Crookneck, and the booming and rumbling of the rock slide caused some alarm in the neighbourhood ; the fissure produced by the fall of this immense mass is plainly visible on its S.E. side.

* In 1875, the late Sir Augustus Gregory, in his report on "The Geology of Parts of the Wide Bay and Burnett Districts," classes the Glasshouse Mountains with Mounts Cordeaux and Mitchell and Spicer's Peak in the Main Range; and with Mount Lindsay and Mount Barney in the Macpherson Range. He calls the rock in each case a porphyry, and says, "The porphyry consists of a pale brown paste with minute felspathic crystals, though it sometimes varies

so as to consist of very small grains of quartz with minute cavities, containing oxide of iron, resulting from the decomposition of pyrites. Occasionally, it is vesicular, and has the aspect of trachyte." In speaking of the rock as consisting of a brown paste, Mr. Gregory must have had rocks of the Beerburrum type in view, and he very nearly gave their true composition when stating that they had the aspect of a trachyte. As a matter of fact, all these mountains are built up of forms of columnar trachyte in six-sided prisms.

Leichhardt compared the Glasshouses to the Puys of Auvergne, a group of detached cones scattered over the centre of France, some of which still retain their cone-shaped slopes and central crater, while others have reached the state of denudation shown in our Glasshouses, and are reduced to the central plug of crystalline rock. The Puys are also columnar in structure, as may be seen in the illustration handed round.

A letter of Leichhardt's, dated September, 1843, says: Last Saturday I returned from a trip to the Glasshouses; the highest, Beerwah, is about 1,000* feet high, and is composed of a rock entirely different from the surrounding mountains; I have seen similar mountain features in Auvergne. Geologists have called this rock domite, because of its affecting the form of a dome. This domite belongs to the trachytic group.

The Rev. J. E. Tenison Wood believed the rocks of the Glasshouses to be basalt, and in his paper on the "Desert Sandstone of the interior of Queensland," published plates showing "Prismatic Basalt, Glass House Mountains."

Mr. Henry G. Stokes, formerly a member of this Society, was the first to show conclusively that the rocks of the Glasshouses belonged to the Trachyte class. Recently, Dr. H. I. Jensen, a Queenslander, and former resident of Caboolture, an ex-scholarship winner, and holder of a travelling science scholarship from Sydney University, has written two exhaustive papers for the Linnæan Society of New South Wales, in which the structure of the mountains, and the nature of their minerals have been fully discussed.

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* The true height is 1,760 feet.

Visitors to the mountains should stay at Bankfoot House kept by Mr. Grigor,* an old resident, who can supply horses and guides. The nearest railway station is Glass Mountain Station, distant about 45 miles north of Brisbane. Bankfoot House stands right in the centre of the Glasshouses. The mountains lie roughly on north and south lines in groups of three; each group of three lies on a transverse axis, cutting the N. and S. axis almost at right angles. Taking the three lying immediately north of Grigor's—Ngungun, Coonowrin and Beerwah—it will be found on ascending Ngungun, an easy feat by climbing round its south-eastern face, that the points of the other two lie from Ngungun in one and the same straight line. North of these, Mount Mellum, Mt. Blanc and Candle Mountain lie along a parallel straight line, and to the south on a third parallel lie Barren Mountains, Tibrogargan and Mt. Ewan, while south again on an east and west line are Beerburrum and the twin peaks of Toonbubudla. The theory advanced by Mr. Lionel Ball, and by Mr. Jensen is that the north and south lines represent immense faults or fractures or lines of weakness in the rocks north of Caboolture, and that these fractures when formed along north and south folds cause smaller cross fractures. If we press with a straight piece of wood on the surface of a pie crust, the crust will not only break along the line of pressure, but also in numerous places at right angles to the main fissure. Mr. Stokes asserted that there were two or three main lines of fracture parallel to the coast, and that each extinct volcano was placed where the cross faults or fissures cut these.

The columnar structure of these mountains is evident from a distance, on each mountain the columns in the centre are vertical, but on the slopes are parallel to the angle of slope, and all converge towards the summit. The columns on Toonbubudla, the twin peaks, present a very curious structure. Where the end of a prism is exposed, it looks like a gigantic honeycomb, each column is again divided into many smaller prisms, which are similar in shape to the parent mass. The various peaks do not show the greatest effect of denudation on the side facing the sea,

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* Since writing the above news of Mr. Grigor's death has been received.

and the prevailing winds. Ngungun is weathering most rapidly from the south, Coonowrin from the south-west, Beerwah from the north, and Toonbubudla from the north-west. Toonbubudla and Beerburrum seem to weather almost equally towards all points of the compass.

The columnar structure may best be studied in the caves at the foot of the column on Coonowrin. Though they are usually six-sided, there are exceptions to the rule in four and-five-sided prisms.

The most porphyritic rocks are those of Beerburrum and Ngungun. The formerly usually weathers a rich red-brown. Specimens from Beerwah and Beerburrum have been classified by Mr. Jensen as Trachyte; those from Coonowrin, Tibrogargan and Ewan as Comendite; and those from Ngungun as Pantellarite, a soda trachyte in which the percentage of silica ranges from 66.8 to 72.5, and alkalies, principally soda, amount to 10 p.c.

The heights of the principal peaks are:—Beerwah, 1760 feet; Coonowrin, 1170; Toonbubudla, 1020; all the others are below 1000 feet.

The Glasshouses arise from Trias-Jura beds, while immediately to the west of them are rocks of Carboniferous age. With regard to the age in which they were formed, all that we can say is that they are more recent than the Trias-Jura, and older than the surrounding basalts.

GRAPHICAL AND MECHANICAL AIDS TO CALCULATION.

By J. C. BRÜNNICH, F.I.C.

A Paper read before the Royal Society of Queensland on May 25th, 1907.

In every station of life arithmetical calculations are absolutely indispensable: no trade, no profession, no calling, however humble it may be, can exist without a continual practical application of one of the three great R's in the solving of arithmetical problems. Such calculations become in many cases a monotonous mental drudgery, and from the earliest times mathematicians have tried to invent instruments and tables which should minimise such work in all scientific, commercial and industrial calculations.

In our present state of civilisation, in which the keen industrial competition becomes a veritable struggle for life, with "time is money" as its principal motto, such aids become more than ever invaluable, and I can positively state from my own experience, that with the help of graphical tables and more particularly with the use of slide rules, I have saved 75% of the time otherwise spent in calculations.

The object of this paper is to spread the knowledge of such instruments and to awaken the interest of a few, so that they like myself become apostles advocating the employment of graphical tables and of slide rules. This paper does not claim to be a scientific treatise on the subject, neither can I enter into explanation of the more expensive instruments, like arithmometer, used for complicated astronomical calculations, and the elaborate adding or counting machines, which are more and more introduced into the offices of our larger banking institutions.

I shall first treat briefly with graphical tables or diagrams, also called graphs, and show one of the oldest graphs in existence: Pythagoras table of multiplication (Table I., Plate 1). The construction is of the simplest, on a horizontal line ten equal divisions are traced, numbered from 0 to 10, the same is repeated on a perpendicular line erected on the zero point, and the whole square completed. Every product of multiplication is indicated by the point where the horizontal line of a given number crosses the vertical line of another number; by connecting all products of equal numerical value, a system of curves will be obtained, with the help of which the product of any two factors may be read off. Every line representing the same quantity is called an "*isoplethe*" (this term was first proposed by the German mathematician, Vogler, and has been universally adopted by others), and we find on this graph three series of isoplethes, two systems of straight lines representing the factors and a system of curves representing the products. To obtain the products with fractions of whole numbers, the values must be estimated by interpolation, which makes the table of little practical value. This table serves to illustrate the simplest of forms applied to three variables, in which two given values determine a third unknown.

The celebrated French engineer, Leon Lalanne, discovered the principle of *anamorphosis*, by which the construction of graphs is simplified, and their utility greatly increased. This principle is based on the following consideration:—Each scale must be considered extensible, as if drawn on a sheet of rubber, each scale can be so stretched and transformed that the curves become straight lines, which not only simplifies the construction, but greatly facilitates the reading. Lalanne thus modified Pythagoras table of multiplication by stretching the horizontal and the vertical scales in a peculiar manner with the result shown on the left of Table I. that the isoplethes of products become straight lines running diagonally, and cutting both the horizontal and vertical isoplethes at the number of their actual value. On this improved table of multiplication, the squares and cubes of numbers are easily found by drawing diagonal lines, for the squares from 1 to 100, and for the cubes from 1 to 3.162 ($= \sqrt{10}$) and from 3.162 to 100, and reading the results at the point of intersection of ver-

tical lines and diagonals. Lallemand, another French mathematician, was the first to construct hexagonal graphs, in which, with the aid of a transparent sheet, on which the three diagonals of a hexagon are drawn, the value of an unknown may be found from two given variables. He further extended the principle by making each of the scales a system of two variables and thus producing a graph on which the relation of six variables is recorded. On Table II., Plate I), which represents one of Lalanne's hexagonal graphs, we have thus three double systems, one with the variables, u and v, the second with the variables, y and z, and the third, with the variables w and x, and for $u=30$, $v=20$, $y=50$, $z=20$ and $w=20$, we find $x=4$. In the reading of these hexagonal graphs, attention has to be paid that the diagonals of the transparent sheet cut the systems perfectly perpendicular. With the help of similar tables, Lallemand succeeded in the general topographical survey of France to reduce to quite simple reading off, long complicated calculations, which previously occupied for days the time of several persons.

As a practical example of such a hexagonal graph, I give here a Table (III., Plate I), for the calculation of compound interest, constructed by Prévot, which for a given amount of capital, a given rate of interest and given time in years, allows to read off the amount of capital plus compound interest. For instance, £225 at 3 per cent. will increase in thirteen years to £328.

One of the greatest authorities on graphical calculations of the present day is the French enginneer, Maurice d' Ocagne, who proposed the term *Nomographie* for this science, which term is now generally used in Europe, on which he published several works. He was the first to extend and simplify the principle of graphical calculations by inventing a system by which the three factors are read off on a straight line. I will give here an instance of this principle by showing a Table (IV., Plate I), published only a few months back, constructed by Fischer for the calculation of the amount of alcohol in wine. A wine with a specific gravity of 1.0520 yielded an alcoholic destillate with a spec. gr. .9778, contained in accordance with this table 13.84 per cent. by weight of alcohol.

D'Ocagne extended the science of nomographie in every direction and he succeeded in laying before the French Academy of Science a method by which he constructed nomographs with ten and more variables. I will give here another example of one of d'Ocagne's nomographs, as applied to higher mathematics, the graphic solution of the cubic equation, $z^3+pz+q=0$, we find from Table VII. that for $p=2$, and $q=-6$, $z=1.46$.

As another instance of reading a result with the aid of a straight line, I will give here a very simple graph, which I constructed for use in sugar laboratories for the calculation of the well-known value *Pure Obtainable Cane Sugar*, or P.O.C.S. in sugar cane (Table V., Plate II.) In cane juice, the amount of total solid matter is determined by a density determination with the aid of Brix or Beaumé spindle. The degree Brix express the percentage of total soluble solid matter in the cane juice, which value is read off in our table on the third perpendicular scale on the right. The amount of cane sugar in the juice is determined with the help of the saccharometer or polariscope, the value found is read off on the centre scale, by connecting the per cent. of brix and per cent. of cane sugar by a straight line, the amount of P.O.C.S. is read off on the left hand scale where it is cut by this straight line. I may be allowed to explain that the amount of sugar obtainable by the process of manufacture not only depends on the actual amount of cane sugar in the juice, but also on the amount of soluble impurities, and from practical experience the manufacturer estimates that one-half of these impurities have to be deducted from the per cent. of cane sugar in the cane. We have for instance two cane juices both nineteen degrees Brix, one with seventeen per cent., and the other with fifteen per cent. of cane sugar, the former has sixteen per cent. and the latter only thirteen per cent. P.O.C.S.

I will now show a chart which I constructed for the use of dairies and butter factories, by the aid of which for a given quantity of milk containing a certain per centage of butter fat, the amount of commercial butter which should be obtained by churning, may be read off. (Table VI., Plate II). A cow giving, say, 21lbs. of milk with a 3.8 per cent. test, would yield 14ozs. of commercial butter a day. The formula

used for the calculation of the result is not a simple one, as shown on the top of the table, but by the aid of this nomograph correct results are obtained, without turning over pages and pages of tables of the tabulated works generally used in our factories, which tables moreover give the results in pounds and decimal points of pounds which values are not so intelligible to our farmer. A similar chart I constructed for the calculation of commercial butter from given quantities of cream. As a further instance, I will show here a table used for the calculation of the amount of water evaporated to concentrate a sugar juice of a given degree Brix into a syrup of certain degree Brix. The original table gave the amount of water evaporated in per centage of weight of the original juice, I extended the utility of the table so as to be able to find directly the gallons of water evaporated per 100 gallons juice.

With the graphical aids to calculations may be included an ingenious little instrument, costing only a few shillings: the *mathematical Cinderella*, or *Engineer's Messknecht* (measuring or rather computing servant), so called by its inventor, Hofrath Prof. Max Pressler. This table of handy pocket size, constructed of strong card board, has on one side a complete table of logarithms from four to five places, with many other useful data and constants with reference to weight and measures, etc. On the other side are other graphical tables of reciprocals, circumference and surfaces of circles of various diameters, squares and cubes of numbers, chords, arcs, sines, cosines, tangents and secants of all angles. The instrument may be used, like a regular multum-in-parvo, for rough surveys and levelling, for the estimation of true sun time, the estimation of heights of trees and mountains, for the estimation of the cubic contents of standing and felled trees. To give an instance how handy the arrangement of these tables are for calculations, which otherwise would require large volumes of tables, I will give an example taken at random from the little pocket book, issued with the instrument. In a railway to be constructed, the line of rails has to change its direction by an angle of 31.4 degrees, and the lines have to be connected by a curve 200 yards radius (See Plate II.) The surveyor wishes to know :—

1. Length of chord BC$=200\times$ chord 31.4 degrees$=2\times54.12$ $=108.24$ yards ;
2. Height of arc FS$=200$, height of arc $31.4=2\times3.73=$ 7.46 yards ;
3. Length of arc, curve CFB degrees$=200\times$ arc $31.4=$ $200\times.548=109.67$ yards ;
4. Surface of segment$=200^2$ seg. 31.4 degrees$=40000\times$ $.0134=536$ sq. yards ;
5. Distance CD and DB$=200\times$ tang. 15.7 degrees $=$ $200\times.281=56.2$ yards ;
6. Distance DM$=200\times$ sec. 15.7 degrees$=200\times1.038\times$ 207.6 yards.

I will now pass to the mechanical aids to calculation and draw first attention to the simplest of all such insturments the ordinary ball frame, which is still extensively used in all business houses in Russia, and is also in common use in China and a few other countries. It is quite a revelation to see a Russian bank clerk doing all his adding up and other calculations with the help of a ball frame, with the greatest of speed and absolute accuracy, and with the great advantage that he may be interrupted at any time during his calculations without affecting the result. Some years back a small portable instrument was patented in America, the "Locke Adder," which is based on the same principle as the ball frame, and is worked in exactly the same manner. It is of great advantage for adding up, but not so easily applicable to our system of money with its pound, shillings and pence. With practice any arithmetical operation addition, subtraction, multiplication and division may be done with the little instrument.

By far the most general useful of all the mechanical devices invented to aid calculation are *sliderules*, of which a great many forms exist. In 1624, ten years after the invention of logarithms by the Scotchman, John Napier, who published the first table of his natural or hyperbolic logarithms in 1614, the English mathematician, Edmund Gunter, constructed a rule which he divided in proportion with the loragithms of numbers, with which he used a pair of compasses to obtain results of multiplication and division. Gunter was a colleague of Prof. Henry Briggs, of Gresham College, London, who was the originator of the more gener-

ally used decimal or common logarithms. Already in 1657 Seth Partridge constructed a logarithmic slide rule with Gunter's scales, which is really the forerunner of all the sliderules in use at the present day. Although England is the home of the original inventors, the use of sliderules made very little progress in the country, and only within recent years more attention has been given to the little instrument, which is becoming of more general use. In France, Germany and other European countries sliderules are very much more extensively used, and are not only used by nearly every scientist, but are found in the hands of every artisian, mechanic and engineer. The reason that sliderules are less used in England and its Colonies lies unquestionably in the fact that the ordinary worker on account of the complicated system of weight, measures and monies, is not so accustomed with the use of decimals, but does most of his calculations with vulgar fractions.

The principles, a mechanical and mathematical one, on which the use of sliderules are based, are exceedingly simple and easily understood. We will first consider the mechanical principle, which is easily demonstrated by taking two ordinary scales divided into 10 equal parts, in contact with each other (Table VIII., Plate III), by now moving the lower scale until the zero falls below a certain number, for instance three, in the upper scale, we will find that every other number on the upper scale is equal to the sum of the coinciding number on the lower scale plus three. This gives a simple method of adding a number taken on one scale to any number on the other scale. Similarly substraction may be demonstrated by placing the number to be deducted underneath the number from which it has to be substracted, for instance, four from seven, and to read off the result of the substraction over zero of the lower scale on the upper scale, which equals three. For certain operations the lower scale may be inverted, and in this case we will find that the sum of all the coinciding figures on the two scales is constant, and as an example we find on our table that this sum of numbers is seven. We now see that with the slide inverted the sum of the numbers is constant, whereas with the slide direct the difference of numbers is constant.

The mathematical principle is equally simple, and is based on the theory of logarithms, in accordance with which multiplication of numbers is simplified into the addition of their logarithms, division into subtraction, the raising of a number to the *n*th power by multiplying the logarithm by *n*, etc. On a slide rule the two principles are combined, the scales are divided in accordance with the logarithms of numbers, and we find at once that the mode of division is exactly the same as on Lalanne's table of multiplication. If we have now two such logarithmic scales in contact with each other, and place for instance the index 1 of the lower scale under the 2 on the upper scale, we find that in all pairs of numbers in coincidence the number on the upper scale is the product of the number of the lower scale multiplied by two. Again we find that all pairs of numbers are in direct proportion with each other, in our case $2 \div 1 = 4 \div 2 = 6 \div 3 = 8 \div 4 = 10 \div 5$.

If we invert the slide or lower scale, we will find in accordance with the mechanical principle that the products of all numbers in coincidence are constant, in our case $5 \times 1 = 2 \times 2.5 = 2.24 \times 2.24 = 7.07 \times 7.07$, which latter numbers are on the square roots of 5 and of 50.

On the ordinary *Mannheim sliderule* of 25 centimeter or about 10 inches length we find two scales of divisions from 1 to 10 each on the upper part of the rule, and a scale from 1 to 10, but of double length on the lower part of the rule, and similar scales on the upper and lower part of the movable slide. With this rule only approximate values (A, Plate III), can be obtained, which for most calculations is quite sufficient. The reading of the subdivision requires some practice. On a sliderule all operations of calculations are made irrespective of the decimal point, and for instance the values of .0265 or 2.65 or 2650 are taken on the same place on the scale. Rules exist to ascertain the position of the decimal point, but they are rarely required, as in practical calculations the position of the decimal point is generally self-evident.

As the accuracy of the results of operations made by the aid of a slide rule depends entirely upon the number of subdivision on a given length of scale, sliderules of great length up to three feet have been constructed, which how-

ever, on account of their length, become unwieldy. The lengthening of the scale may also be achieved by dividing the scale into two halves, with the first half of the scale on the upper part of the rule, and the second half on the lower part, and to make the instrument with two slides, as in the slide rule invented by E. Peraux, which although only 25 centimeter long, corresponds in accuracy with a rule 1 metre long, and gives results accurate to at least four figures (Plate III., B.). Of still greater accuracy is the *cylindrical slide rule* of Prof. George Fuller, in which a logarithmitic scale over 40 feet long, is wound round a movable cylinder, and with which calculation with an approximation of $1 \div 10{,}000$ are obtained. On this instrument we have only one scale of numbers and the operations are based on the same principle as originally employed by Gunter, by taking the first factor from the scale with the aid of two indices, and then moving the scale and reading off the result on the scale with one or the other of the indices. This sliderule gives by far the most accurate results, but has the disadvantage that if several operations with a constant factor have to be made, the scale has to be shifted every time. This drawback is avoided in the horizontal cylindrical slide rule by Thacher, which has a scale of 30 feet length, divided into 40 parts of equal length arranged parallel on a moving cylindrical slide, which is surrounded by a framework of triangular bars carrying similar scale. With this rule nearly the same approximation as in Fuller's rule is obtained, but with the great advantage that a series of multiplications or divisions in which one of the factors is constant can be made with only one setting of the slide. The bars further carry a scale of squares which gives a much greater range of possible calculations. Futhermore the slide has two series of scales running parallel so that the results may be generally obtained at two different places, and unnecessary shifting and drawing out of the slide is avoided. Both Fuller's and Thacher's rule are only for office use.

Quite of late years the ordinary Mannheim rule has been greatly improved by *Prof. A. Beghin*, who introduced his new slide rule (Plate III., D and E.) towards the end of 1898, and which now almost entirely replaces the older

sliderules, as it gives much greater accuracy than any other rule of the same length, is easier to work, and has a far greater range of possibilities in calculations, as for instance it allows with only one setting of the slide direct multiplication of three numbers or the finding of the quotient of a number divided by the product of two numbers. Calculations like $x=a.b.$, $x=a.b.c.$, $x=a.b.\div c$, $x=a\div b\ c$, $x=\sqrt{a}$, $x=\sqrt[3]{a}$, $x=a.b^2$, $x=a^2\div b$, $x=a:\sqrt{b}$, $x=\sqrt{ab}$, $x=\sqrt{\frac{a}{b}}$, $x=a^2\sqrt[3]{b}$, $x=\sqrt[3]{a^2b}$, $x=a^3\div b^2$, $x=\sqrt{a^2+b^2}$, $x=(\sqrt{a}+\sqrt{b})^2$ can be solved with the greatest of ease with one single movement of the slide. Special scales on the reverse of the slide give natural sines and tangents of angles, and allow trigonometrical calculations.

Just to give one example of the use of the sliderule in technical calculations. In order to make the results of analyses strictly comparable the results of the analysis are calculated on to the percentage of dry substance. We find for instance a sample of sorghum containing after air drying 10.15 per cent. of moisture, to contain starch 23.80 per cent., soluble carbohydrates 10.65 per cent., fat 2.56 per cent., ash 7.06 per cent., woody fibre 36.60 per cent., nitrogen 1.225 per cent., and proteins 7.35 per cent., and with one setting of the slide by setting the 10 on the rule to 89.85 amount of dry substance on the slide (as on top of double rule, Plate III., B), we can read all the results off from the amounts taken on the slide with the coinciding figures on the rule and get 26.50 per cent.. 11.86, 2.85, 7.86, 40.75, 1.364, 8.18 per cent. respectively.

Practical calculations are very much simplified by using conversion factors or gauge points, for instance, to convert feet into metres we use the proportion feet : metre as 292:89 or the factor .3048. The relation between the circumference of a circle and its diameter is very accurately expressed by the factor 710:226. If we read an European work on agriculture we find all the results of harvest expressed in hectolitres per hectare, and we can convert this into bushels per arce by multiplying the numbers by the factor 1.1133, or setting the slide to the proportion 150/167.

Every user of the sliderule, after becoming once familiar with the instrument, will find that certain factors are mostly

used in his calculations and he can fix them by making marks either on the rule or on the slide. Movable metal runners, called cursors, which have a fine vertical line marked on a piece of glass, facilitate in many cases the operations and the setting and reading off, but are particularly useful in continued operations like $a.b.c.d. \div e.f.g.$

I may here add that for office use slides with the scales arranged on circles have been constructed, which, however, have no advantage over the slides already mentioned. Another pocket arrangement is a scale invented by *Proell*, on which we have a scale divided into ten equal parts printed on a small card, and a similar scale printed on a transparent sheet of celluloid, which is moved on top of the scale on the cardboard.

I trust that the examples I have given are sufficient to clearly demonstrate the value of mechanical and graphical aids to calculations, and so that they may be more commonly be used as time and labour saving inssruments.

In order to enable any student to get some more information on this interesting subject, I will enumerate a few of the publications dealing with graphic calculations and slide rules :—

L. Lalanne.—Memoires sur les tables graphiques et sur la géométrie anamorphique.

do. Méthodes graphique pour l'expression des lois à trois variables.

Lallemand.—Les abaques hexagonaux. Feuilles lithographiées en 1885.

M. d'Ocagne.—Nomographie.—Paris, Gauthier Villars.

do. Sur une méthode nomographique. "Comptes rendues de l'académie des science," juillet 1893.

L. Lalanne.—Instruction sur les règles a calculs. —Paris.

Quintino Sella.—Teorica and pratica del regola calcolatore. Torino.

Elliot.—A treatise on the slide rule. London.

A. Beghin.—Règle a calculs. Paris.

C. N. Pickworth.—The Slide Rule.—Emmott and Co. Manchester and London.

M. R. Pressler. — Mathematisch — Polytechnische Brieftasche mit Ingenieur Mess-Knecht.—Wien. Moritz Perles.

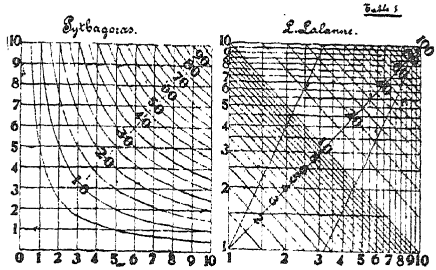


Table I
Pythagoras.
L. Lalanne.

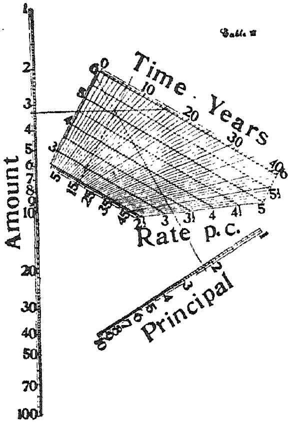


Table III
Time Years
Rate p.c.
Principal
Amount

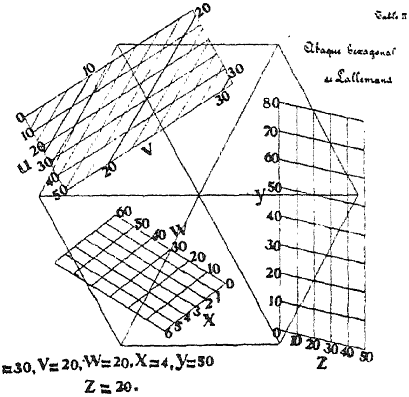
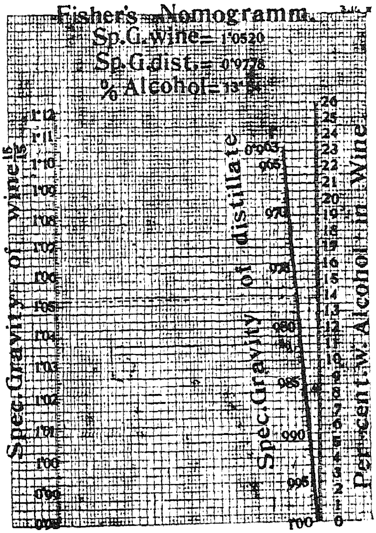
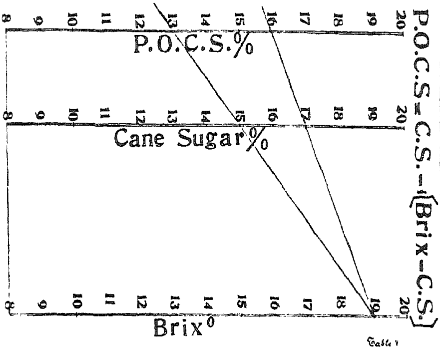
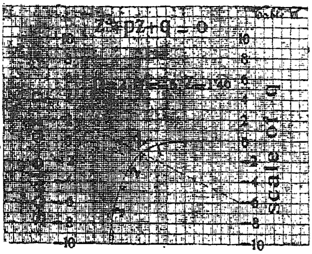


Table II
Abaque hexagonal de Lallemand
U=30, V=20, W=20, X=4, Y=50
Z=20.


Fisher's Nomogramm.
Sp.G.wine= 1·0520
Sp.G.dist.= 0·9778
% Alcohol= 13·86
Spec. Gravity of wine 15/15
Spec. Gravity of distillate
Percent. W. Alcohol in Wine


P.O.C.S.%
Cane Sugar%
Brix°
P.O.C.S.=C.S.−{Brix−C.S.}
Table V


Scale of q

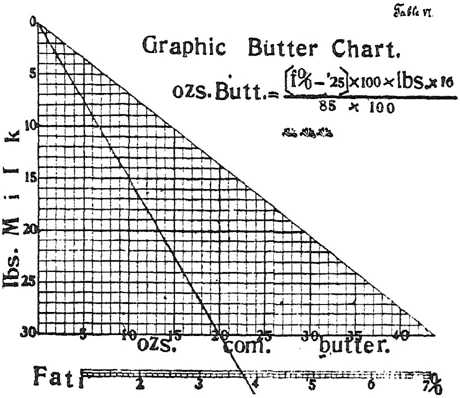
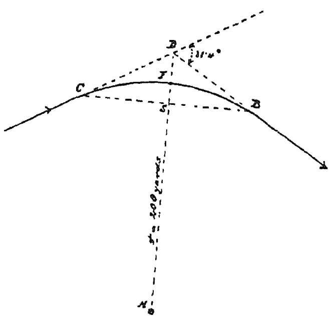
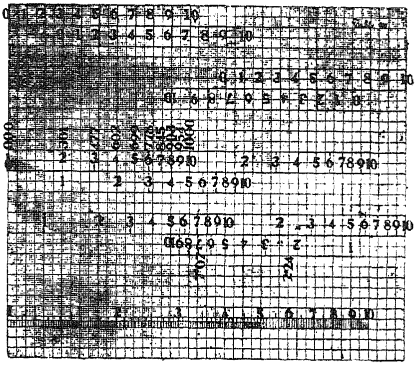
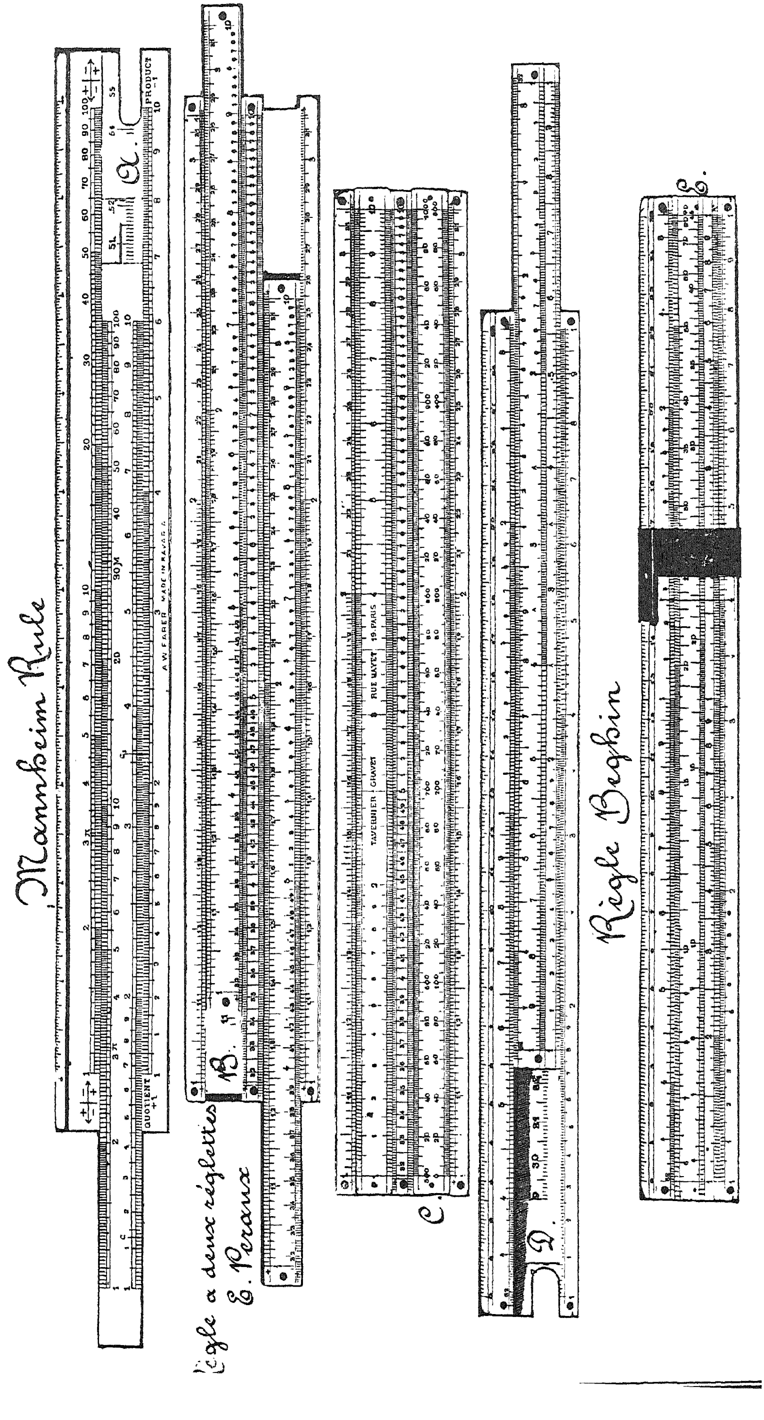


Table VI.
Graphic Butter Chart.
ozs. Butt.= {f%−·25}×100×lbs.×16 / 85 × 100
lbs. Milk
ozs. com. butter.
Fat






Mannheim Rule
A.
Règle à deux réglettes
E. Peraux
B.
C.
TAVERNIER GRAVET RUE MAYET 19. PARIS
D.
Règle Beghin
E.

AN AUTOMATIC HOUSEHOLD FILTER.

A Paper read before the Royal Society of Queensland, on June 27th, 1907.

By J. BROWNLIE HENDERSON, F.I.C.,

(GOVERNMENT ANALYST),

and H. WASTENEYS, F.C.S.,

(ANALYST TO THE BRISBANE BOARD OF WATERWORKS.)

OWING to the water supply of Brisbane being delivered in an unfiltered state, and to its being at times of drought or flood undrinkable and exceedingly dirty, an attempt was made at the house of one of us (Mr. Henderson), to establish an automatic filter for the filtration of the water, which is delivered there from the Brisbane River supply. A similar filter had been found to give very good results with the "soft" Enoggera supply at the Reservoir, but this was the first attempt to treat the "hard" Brisbane River water by this method.

A corrugated galvanized-iron tank was made as in the diagrammatic sketch, with outlet pipe for the filtered water, wash out pipe with cock at the bottom, draw-off pipe with cock at the centre to run off water when cleaning top sand, and overflow, in case of flooding, at the top, the three latter openings being connected to the waste discharge. A perforated galvanized-iron pipe, three inches in diameter, was put down for the underdrain, and over this there was carefully packed washed gravel and sand as per sketch, to constitute the filter. The sand reached up to the level of the draw-off cock. A float in this filter was connected by a cord running over two pulleys to a swing arm attached to the outlet pipe, and to the storage tank pipes by barrel unions, as shown in sketch. To prevent syphon action,

a small pipe is let in at the top bend of the swing arm to admit air. By this means a rise of level of water inside the filter lowers the outlet, so that each inch increase of rise in water level gives virtually two inches more pressure on the filter, thus practically doubling the head of water that can be obtained in the filter. The fall of the swing arm also calls attention to the fact that the filter is choking, but the fall is so gradual that a month can elapse after the arm starts to fall ere cleaning is necessary. Before the filtered water pipe enters the storage tank, there is a draw-off pipe with cock connected to the waste discharge, so that the filtered water can be run to waste for two days after cleaning off the top sand, and thus save the contamination of the clean water already in the storage tank. As the filtered water is always found to be absolutely devoid of oxygen, it is run over an aerator before going into the storage tank. The stored filtered water in the tank is always saturated with oxygen. The pipe from the water main passes close up beside the storage tank, and a floating ball connected through a slot in the tank with a ball cock on the pipe, controls the supply to the filter. The drawing off of water from the storage tank lowers the ball, opens the cock, and water is delivered on the filter until the filtered water again rises sufficiently to close the cock. To regulate the supply to the filter, a small cistern, just large enough for a ball cock, is placed over the filter. In our case, nine inches of water was the depth obtained in this cistern. In the bottom of this cistern there is a standard orifice, with about quarter of an inch of pipe around it to ensure the water dropping straight down and not running along the under side of the cistern. The diameter of the orifice is so adjusted that with the head of water obtainable in the cistern, it delivers water on to the filter at the standard rate of three million gallons per acre of sand surface per twenty-four hours, and cannot possibly deliver faster than this. As the ball cock in the cistern of course delivers at a much greater rate than this, the cistern is nearly always full when the filter is working. The water delivered from the main is practically devoid of oxygen, so we ærate the water by running it down a ripple on to the side of the tank, and find by that means that the water on top of the filter

is saturated with oxygen. By this arrangement of controlling the supply first from the storage tank as to quantity, and secondly, from the cistern as to rate, we have found that the filter works quite automatically. It has been in use for over twelve months with no attention, save that on one occasion, after running nine months, the top quarter-inch of sand on the filter was removed and thrown away. The storage tank, filter and cistern were covered, and made mosquito proof, and the inside of each painted with "bitumen" paint.

The chemical analysis of the filtered water shows that there is always a large decrease in the albuminoid ammonia and in the "oxygen consumed," and the color is almost entirely removed Saprophytic bacteria only are found in the filtered water, averaging from 50 to 100 per c.c. The intestinal bacilli, especially coli communis, are always present in the main supply, but have never been found in the filtered water On one occasion, when the Brisbane River was in high flood, and dark brown, muddy water was being supplied, the filtered water was slightly opalescent, and had a yellowish colour, but that disappeared in a week.

As a result of the use of this filter, there is always on hand a supply of 600 gallons (the capacity of the storage tank) of pure, clear filtered water, which is used for drinking, cooking, and the bath. The advantages of a pure, clear water supply need not be pointed out—they have been well-known for many years. By the use of a filter of this kind, which only costs comparatively a few pounds, such a supply is always assured, while none of the small domestic filters generally in use, although requiring constant attention, can give a supply for the kitchen and bath room, very few of them remove the bacilli present, and a large proportion of them serve as breeding grounds for objectionable microbes.

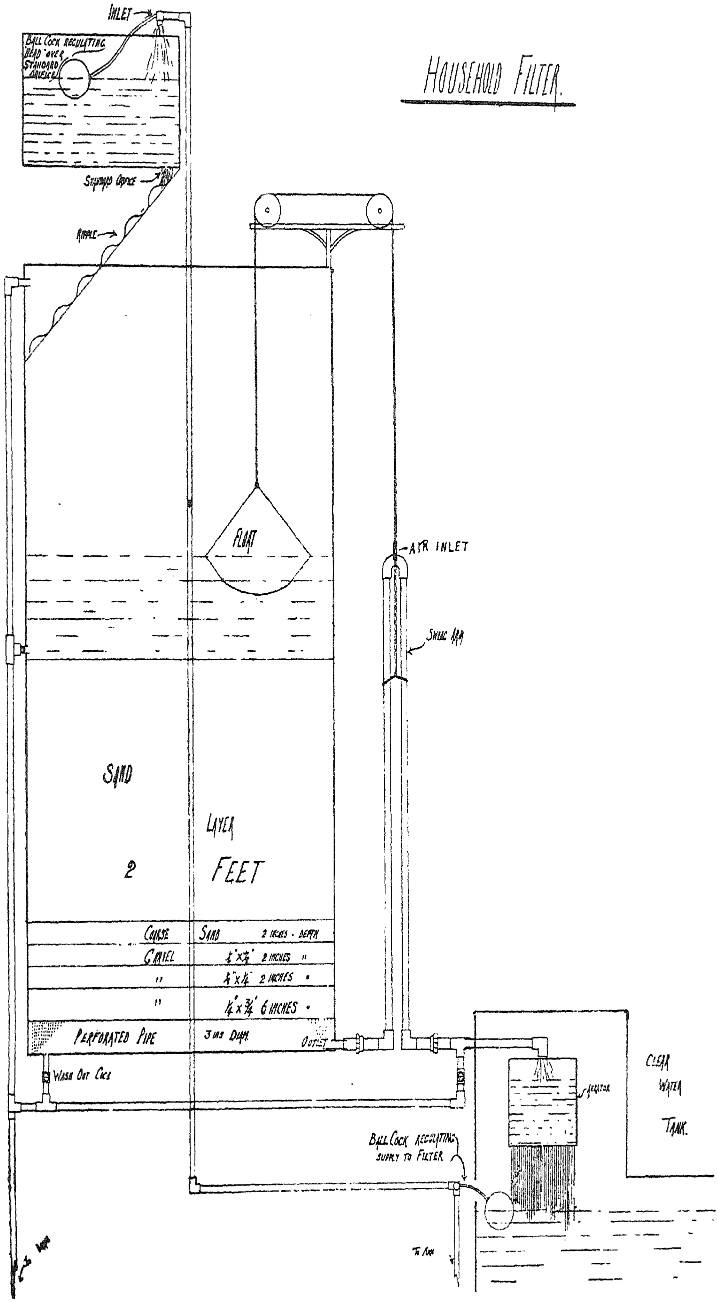
A NEW TEST FOR MERCURY

By P. W. JONES, A.I.C.

A paper read before the Royal Society of Queensland, 27th June, 1907.

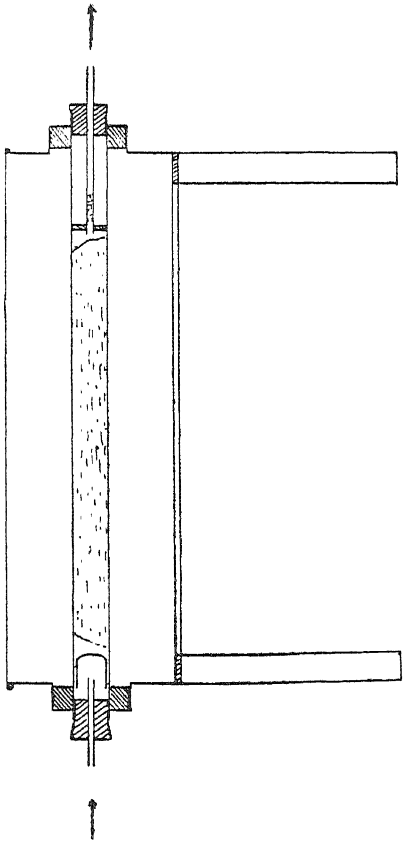
The test is really the application of the action of mercury upon aluminum. When aluminium is rubbed with wash leather impregnated with mercury, combination takes place, forming an amalgam. This action is materially assisted and hastened by placing a drop of a solution of a caustic alkali on the aluminium before rubbing. When exposed to moist air, the alloy loses its lustre and the surface becomes oxidised with the formation of concretions of white aluminium oxide, and the liberation of mercury, at the same time evolving a considerable amount of heat.

The test as applied in Toxicology is of considerable value in that very small quantities may be readily detected; thus, a convenient portion of the sample is taken, placed in a flask together with a small strip of copper foil attached to a platinum wire and boiled as in Reinsch's test. The copper is then taken out of the solution, washed lightly with hot water, then with alcohol, and ether, dried, and cut into strips and placed in a small hard glass tube, sealed at one end and the mouth expanded. The tube is then suspended in a hole in a stout brass or copper plate. Over the mouth of the tube is placed a piece of metallic aluminium, previously cleaned, and a drop of water on the top of the aluminium to prevent the temperature rising too high. The bottom of the tube is then carefully heated to a dull red heat, kept at that temperature for a minute or two, then allowed to cool. Take off the aluminium strip, and rub the part where the mercury may be deposited with a wash leather moistened with a drop of caustic alkali, allow to stand in a moist atmosphere for a few minutes, charac-


HOUSEHOLD FILTER.
INLET
BALL COCK REGULATING HEAD OVER STANDARD ORIFICE
STANDARD ORIFICE
RIPPLE
FLOAT
AIR INLET
SWING ARM
SAND
LAYER
2
FEET
COARSE SAND 2 INCHES - DEPTH
GRAVEL 2 INCHES
2 INCHES
6 INCHES
PERFORATED PIPE 3 INS DIAM.
OUTLET
WASH OUT COCK
AERATOR
CLEAR WATER TANK.
BALL COCK REGULATING SUPPLY TO FILTER

teristic growths of $Al_2 O_3$ will be seen if mercury is present. 1-500th of a grain of mercury may be detected in viscera, etc., by this method. The advantage this method has, is that small quantities of impurities such as fatty matters do not interfere.

To detect small quantities of mercury in an ore.—Take from 0.5 to 1 grm. of the thoroughly sampled and finely ground ore and mix with about an equal bulk of lime and a little reduced iron (or other reducing agent), and place it in a small combustion tube placing a strip of aluminium, previously cleansed, over the mouth, and heat the mixture to dull redness, keeping the aluminium cool with a few drops of water. Then rub the aluminium with a wash leather moistened with a caustic alkali solution. If mercury is present in the ore, there will be the characteristic growth of alumina.



THE DETECTION OF SMALL QUANTITIES OF MERCURY IN EXPLOSIVES.

J. BROWNLIE HENDERSON, F.I.C. and P. W. JONES, A.I.C.

A Paper read before the Royal Society of Queensland, 27*th June,* 1907.

CONSIDERABLE trouble has arisen recently through the use of mercuric chloride by certain manufacturers in making up explosives, and this addition as is well-known masks the Abel Heat Test.

So far as we have heard in Brisbane, both from published accounts and from private sources, no satisfactory chemical method of detecting the small quantities of mercury present in the explosives has yet been discovered, and in some prosecutions in London for the presence of mercury in explosives, the Government witnesses, including among others, Dr. Dupre and Sir Wm. Ramsay, relied solely on the spectroscopic method for the detection of mercury. In communicating with Mr. W. A. Hargreaves, Government Analyst of South Australia, on this subject, he informs us that the following method has been found to work well qualitatively in his Laboratory: 100 grammes of the explosive was ground up with 100 grammes of french chalk and heated in a flask in a water oven. Air was drawn through the flask gently for two hours, and then passed through dilute sulphuric acid to absorb the mercuric chloride volatilised. This acid was subjected to electrolysis, using a gold cathode and platinum anode. The gold was then dried and heated in a small combustion tube and the mercury volatilised on to a microscope slide and examined under the microscope. We had succeeded in detecting traces of mercury by one or two rather long and unsatisfactory wet methods, but on getting this information from Mr.

Hargreaves, we also adopted the volatilisation method, that he and Dr. Dupré had found useful, and with our method of abstracting the mercury from the vapour found the detection of mercury easy both qualitatively and approximately quantitatively.

A number of preliminary experiments were made and we determined that mercuric chloride could be easily and completely volatilised at 100 degrees C., that a very small quantity of silver foil absorbed the mercuric chloride vapour quantitatively at 100 degrees C., and that on heating the silver after the experiment in a combustion tube in the usual manner the mercury could be readily recognised even in small fractions of a milligram.

The apparatus shown in sketch was then constructed. The water bath is 450 mm. long by 150 mm. wide and 150 mm. deep, on legs 200 mm. long. At each end is a hole 70 mm. diameter, with a short collar projecting 20 mm. An indiarubber cork fits each hole, and a glass tube 30mm. in diameter and 510 mm. long passes through the rubber corks, thus enabling the tube to be surrounded with boiling water. 100 grammes of the explosive to be tested is ground up with 100 grammes of the French chalk prepared for heat test work, and the mixture run into the tube while it is held nearly vertical, a temporary stopper being put in the tube 60 mm. from one end. We found it convenient to do this while the tube was in place in the bath. The 200 grammes of mixture then loosely occupy about 350 mm. of the tube. At the shorter unoccupied end of the tube, a glass "thimble" about 25 mm. in diameter is inserted close to the mixture to prevent back currents and in the end of the tube is inserted a cork and through the cork passes an open glass tube of about 5 mm. diameter. This provides for the inlet of air. A perforated cork is fitted into the other end of the large tube and through the perforation is fitted a small glass tube about 5 mm. diameter and 140 mm. long. Close to the inner end of this narrow tube there is a constriction and pushed up against the constriction so as to loosely fit the tube are two leaves of silver foil, occupying about 15 mm. in length of the tube. By this means the mercuric chloride vapour never comes into contact with a cold surface, the tube and silver foil being

of course also at 100 degrees C., thus preventing loss by condensation. To prevent back currents into the colder end of the wide tube, a section of cork about 5 mm. thick that just fits snugly into the wide tube is fitted over the inner end of the narrow tube, and the tube pushed in till it nearly touches the explosive mixture. There is thus no "dead air" in the large tube and the air sucked through it does the maximum quantity of work in sweeping through the vapour of mercuric chloride. When the apparatus is fitted together, the bath is filled with water, and the water boiled. The "silver" end of the tube is connected to a small wash bottle containing water to control the rate of flow by observing the air bubbles, and the wash bottle connected to a graduated aspirator so that the volume of air drawn through can be measured. We found by experiments that no mercury escaped the silver foil when the rate of suction was not greater than eight litres per hour, and this rate was adhered to in all our experiments.

In testing the method, an explosive was first taken which, from its normal heat test (17 minutes) and British origin was presumably free from mercury. The tube containing the silver was weighed before starting the experiment. The explosive mixed with the chalk was heated for two hours and 16 litres of air drawn through. On withdrawing the tube containing the silver, drops of liquid which proved to be nitro-glycerine were noticed in this (and in every other experiment) on the inside of the outer portion of the tube. The tube was therefore washed out with ether (care being taken that no silver was removed) dried, and weighed. In two experiments with this explosive there was no alteration in the weight of the tube and no mercury was recovered from the silver on heating in a combustion tube. The silver was, however, slightly discoloured in each case, probably due to a trace of oxidation, but as there was no increase in weight, the oxidation must have been very slight.

100 grammes of this same explosive were then ground up with 100 grammes of French chalk which had been thoroughly mixed with two ccs. of a solution containing 1 milligram of mercuric chloride per cc. This was equivalent to 1 part of mercuric chloride in 50,000 parts

of explosive. At the end of two hours heating the tube containing the silver had gained 1.4 milligrams, and after another two hours had gained a further 0.4 milligrams or 1.8 milligrams recovered from two milligrams added.

The silver foil was transferred to a small combustion tube 40 mm. long by 5 mm. diameter with ground top, which fitted into a hole in a thick copper plate in the usual way. A microscope slide was placed on top of the tube and a little water on the slide to keep it cool. The tube was heated to redness, and the sublimed mercury condensed on the microscope slide. It was visible as a grey stain to the naked eye, and with a power of 118 diameters under the microscope, the mercury globules were easily distinguished.

Several other experiments were made with the addition of known quantities of mercury chloride, and in every case a recovery of nearly 90 per cent. in 3 hours heating was obtained.

This experiment was repeated with French chalk, to which had been added 1 cc. of mercuric chloride solution containing 0.1 milligram per cc. equivalent to one part of mercuric chloride in one million of explosive. No attempt was made in this case to weigh the tube, nor was a stain visible to the naked eye on the microscope slide, but under a power of 118 diameters many globules of mercury were distinctly visible, so that even smaller proportions than one in a million could be detected with certainty.

A sample of explosive which gave no reaction in the Abel Heat Test in three hours, but which gave the reaction in 17 minutes when thoroughly ground with one leaf of silver foil, gave an increase of 1.4 milligrams in the tube containing the silver foil in the first two hours and a further increase of 0.4 milligrams in the second two hours, thus agreeing exactly with the experiment in which one part of mercuric chloride had been added to 50,000 parts of explosive. On heating the silver as before, globules of mercury were easily recognised with the microscope. A second test of this explosive gave exactly similar results.

Another brand of explosive where the heat test had been lowered from 63 minutes to 9 minutes by grinding with one leaf of silver, gave a gain of 1.6 milligrams in the

first two hours and 0.2 milligrams in the second two hours, the sublimed mercury from the silver being again easily recognised under the microscope. In this experiment a third silver leaf was inserted in the tube close to the others and tested separately for mercury in the sublimation tube, but none was obtained, again confirming the result that air passing at the rate of 8 litres per hour carried no mercuric chloride past the first two leaves. Judging by appearance, the whole of the mercuric chloride is absorbed by the first 5 mm. of silver leaf.

From the above results it seems that not only does the method afford a rapid and easy means of detecting the presence of mercuric chloride in explosives, but enables a fair estimation to be made of the quantity present.

THE ORIGIN OF AUSTRALIA.

By Sydney B. J. Skertchly, (Past President.)

LATE OF H. M. GEOLOGICAL SURVEYS OF ENGLAND & QUEENSLAND.

Read before the Royal Society of Queensland, December 14th, 1907 ; *and repeated April,* 1908.

I. INTRODUCTORY AND EXPLANATORY.

1. From the time when the peculiarities of the fauna and flora of Australia began to be studied, it has been the universal belief that in Australia we have a unique example of an "arrested" continent, which, from long isolation, has preserved many of the features of bygone epochs, especially in its Marsupials. These are pointed out as survivals of the early forms of mammalian life which began, apparently, in Triassic times, and became important in the Jurassic.* As the testimony is practically, indeed as far as I know quite, unanimous on this point, there is no necessity to quote evidence in proof.

2. Yet it is this well-established belief that I controvert ; and I think I can prove that Australia, instead of being the oldest of Continental areas, is in reality the newest. Our flora, unique both in character and distribution, and our fauna, unlike any other, have been evolved upon Australian land, within a very recent period, not dating back in time much beyond the Pliocene, and this colossal change was the direct result of geological alterations in the geography of the area, which brought about deterioration of climate.

3. Briefly, my theory is this. In Cretaceous times, and far into the Tertiary, there was no Australian Continent at all, but, instead, an Archipelago consisting of two main islands, one in the west, the other in the north and east, with a number of smaller islands in between. This, Dr. A. R. Wallace clearly demonstrated in his masterly "Island

* They seem to be missing in the Cretaceous.

Life," and so far our views march together. There was then free water communication right across what is now the middle of the continent; the islands were mountains, and the climate, in consequence, temperate to warm-temperate, equable, and the land bathed with plentiful rains.

4. At this time, and far onward into the Tertiary, neither the plants nor the animals differed much from those of other parts of the globe. The Tertiary flora, for example, was part of what V. Ettinghausen calls the "universal" flora, and might just as well have been called European or North American as Australian. There were, however, no land mammals, and this is most important, and has been overlooked. There is not a trace of any land mammal in any Australian rock older than Pliocene, and this in spite of the continued labours of geologists in our richly fossiliferous, and wide-spread Tertiary deposits.*

5. From the close of the Cretaceous onwards, upheaval was pretty continuous, until eventually the Australian Archipelago was converted into the Australian Continent. By this time, mammals had entered from Asia on the north-east, *via* New Guinea.

6. The immediate result of the upheaval was the cutting off of the water-supply from the central districts, and consequent elevation of the temperature—deterioration of climate had come in the train of enhanced area; Separation had given place to Federation, and the price paid was a heavy one. The old islands had been blessed with an equable, insular climate: they were like Celebes or Moluccas, but not so hot. The new land was, as now, hot and dry—it was semi-desert. Nor was the dryness of the central plains entirely due to diminished rainfall, for, as we shall see, they were robbed of much of the water which would normally have refreshed the soil, by peculiar conditions which turned the floods underground, only to be useful again as artesian water, eagerly, and expensively, sought after by deep borings.

7. Under those conditions the plants and animals had

* A single specimen has been recorded from Tasmania from doubtful older Tertiary rocks. It is, however, quite certain they must have been very rare; but the presence of a few forms does not affect my argument. The vast majority are of late Tertiary age.

either to accommodate themselves to the more strenuous conditions, or die. Many succumbed: but many conquered in the strife: and so we obtained at last a true indigeonus flora and fauna. It was an absolutely new state of things —the plants took on the remarkable semi-desert peculiarities which make them so interesting to the student of evolution, and most of the mammals acquired (or if you will, re-acquired) the marsupial habit.

8. It will be noticed that the cases of the flora and fauna are not quite parallel. It is true that the Tertiary flora of Australia only faintly prefigures the present flora: but this is the case everywhere, though in Australia we can say that the difference is greater than anywhere else.

9. But with our fauna it is different. So far as regards our Marsupials they are truly Australian: truly and entirely new developments. In no part of the world, recent or fossil, is anything analogous to them known. They are the real Australian Native—far more so than the Blackfellow, for he, after all is a man with like passions with ourselves.

It now remains for me to make good my claim.

II. THE FACTORS IN THE PROBLEM.

(a) *Orographical.*

10. The Australian Continent, compared with others, is unmarked by any great elevated areas; only in three parts, all in the eastern coastal region, rising to above 5,000 feet. The greater portion is more or less undulating plain and table land lying between 500 and 2,000 feet. The major part of the west coast, the shores of the Gulf of Carpentaria, and a large portion of central southern Queensland and New South Wales, and extending south to the coast of eastern South Australia, are under 500 feet.

11. The eastern coast, from Cape York to Tasmania (which is geologically part of Australia) is mountainous, and in the central area the Macdonnel and a few other ranges rise to about 4,000 feet.

12. Australia is, therefore, a huge series of table lands and plains, with an elevated eastern rim, and a few scattered central high lands.

13. Speaking broadly, all the land above 2,000 feet is

of Palaeozoic or older Mesozoic age, and so are a great part of the less elevated (500 to 2,000 feet) regions of West Australia, and parts of South Australia and the Northern Territory.

14. The rest is covered with Cretaceous and Tertiary rocks, with wide areas of surface sandy material, which may be the waste of Tertiary or Cretaceous beds, or may be only of comparatively recent sub-aerial origin. Much of this district is practically virgin ground to the geologist, lying in West Australia and the Northern Territory.

(*b*) *Geological.*

15. The beds which chiefly concern us are the Cretaceous and Tertiary.

16. The accompanying map, kindly prepared for me by Mr. L. C. Green, late of the Geological Survey of Queensland, and now the able lecturer on Geology at the Brisbane Technical College, shows the lie of the Cretaceous and Tertiary beds as far as at present known. The Cretaceous boundary is pretty exact, over much of the area, but it must be remembered that a great deal of this formation lies hidden beneath the Tertiary strata.

17. The main point for our present purpose is that the Cretaceous beds cut Australia into two portions—a long, narrow, mountainous area on the east, and (if we include the area faintly hatched as once covered with Cretaceous rocks), a compact area of no great height on the south-west. There are also inliers of older rocks, which stood as islands in the sea.

18. Dr. A. R. Wallace saw this clearly, and the map in his "Island Life," might almost serve my purpose—my map is only truer from including evidence unknown at the time our great philosophical naturalist wrote his charming, and suggestive work.

19. For reasons that will appear, I shall call the entire area the Australian Archipelago, the eastern land-mass *Australia Orientalis*, the western land-mass *Australia Vera*, and the sea between the two Australias, the *Opal Sea*.

20. The whole of these Cretaceous beds are marine, and have yielded a rich harvest of fossils. They fall into two unconformable series, the Lower and Upper Cretaceous, whose sub-divisions and local names do not concern us.

21. The Lower Cretaceous are characterised by thick shales and sandstones, but the important division to us is a remarkable bed described and named by Dr. R. L. Jack, the Blythesdale Braystone, whose boundaries have been traced by my old colleagues, Dr. Jack and Mr. Gibb-Maitland, for hundreds of miles along the eastern flank of the Cretaceous area.

22. This Braystone, which is as porous as sponge, is the basement bed of the Lower Cretaceous, and being exposed by the excessive denudation of the overlying Desert Sandstone, it lies like a catchment-drain along the flanks of the highlands, and drains away the water which would otherwise flow as surface streams over the (in consequence) arid lands to the west. This is a most important factor in our argument.

23. Upon the gently sloping Lower Cretaceous beds, the Upper Cretaceous rocks have been laid down unconformably. Their important member is the Desert Sandstone, whose isolated patches cap the low hills and make them remarkably similar to the Koppies of the South African veldt. The Desert Sandstone marks a late stage in the shoaling of the Opal Sea, but it is most noticeable for our purpose from the great quantity of colloidal silica it contains.

24. It is this colloidal silica which has given to Queensland and New South Wales their treasures of Opal, and hence I call the waters in which the silica was dissolved the *Opal Sea*. Only a minute proportion of the colloidal silica has been converted into precious opal, the mass remaining in the normal form, much of it in the so-called Porcelainite.

25. The country around the Desert Sandstone koppies is strewn with flakes of this porcelainite, like shards upon the Euphrates' plains. But the material is not baked clay at all. It extends over some thousands of square miles, and many miles away from the basalts: moreover, our basalts have very little baking power—they scarcely modify even the lignite upon which they sometimes repose. Again, the rock is not aluminous, but consists almost entirely of an admixture of colloidal and crystalloidal silica.

26. I believe this so-called Porcelainite to owe its origin to the effect of solar heat upon the exposed material —that, in fact, it like the fauna and flora, is the product of

the deterioration of the climate consequent upon the death of the Opal Sea. The central portions of Australia were converted, in fact, into a huge sand-bath. This idea I have elaborated somewhat in my recent work, "The Story of the Noble Opal," and shall further develop in a forthcoming work on "The Origin of Australia." It suffices to point out that one may say scientifically as well as epigramically that the Opal and the Kangaroo have a common origin.

27. The Opal Sea must have been much like what its present representative, the Arafura Sea, is now—so shallow that it is rather submerged land than ocean. One can anchor anywhere between Australia and New Guinea, and there is no really deep water between there and Borneo or the mainland of Asia. But the Opal Sea was not obliterated by infilling of sediment—elevation had much to do with the process, which was not completed until Tertiary times, an additional reason why the term Cretaceous Sea is inappropriate. The elevation was most rapid in the north, so that at an early date the cooler southern waters were cut off from what is now Central Australia. The first union of Australia Orientalis with Australian Vera was to the north—and to this day, the continent, as a whole, slopes downwards north to south.

28. Of the Tertiaries it is only necessary to speak in general terms. They prove that elevation continued till Australia became a continent, and widely distant land- and fresh-water deposits, from the extreme north to Tasmania, with beds in many places rich in plant remains, show how different the flora was from that which now occupies the area, and stranger still, prove that, as yet, no land mammal has reached even Australia Orientalis. What these geological conditions tell us of the old climate we must now proceed to unravel.

III. THE CLIMATE OF THE AUSTRALIAN ARCHIPELAGO.

29. That the climate of the old Australian Archipelago must have been very different from the present arid conditions is almost self-evident. Picture the state of affairs. A long, narrow, mountain land in the west, singularly like

Java or Palawan, or one of the many of the lovely isles of the Indian Archipelago, stretched some 2000 miles from Cape York to Tasmania. Probably it was connected with New Guinea also. This was Australia Orientalis. On the other side of the Opal Sea to the west, a large compact island, like Borneo without its high mountains, which in all probability extended much further west than the present coast. This was Australia Vera. Between these were smaller islands, some quite mountainous. What climate must they have inevitably enjoyed ?

30. Surely not an extreme one such as prevails now. In the first place there was a free mingling of warm waters from the north and cooler waters from the south, whose joint action was to ameliorate the heat. The waters of the Opal Sea flung their vapours upwards into cloud-wreaths, which shed their life-giving burdens upon the many islands—there could have been neither drought nor fervent heat, any more than is experienced in the sister islands of the Far East. The mountains were higher then than now, and there is distinct evidence that in Tertiary times snow and ice were not unfrequent even in the neighbourhood of Brisbane.

31. Nor is this a mere inference from orographica conditions. There is positive evidence in the plants and animals. The first piece of evidence is negative, and I may say it is almost too strongly in my favour—too perfect. I have great hesitation in inferring temperature from life-forms so far back in time as to the Cretaceous : but as the palæontological is backed by the physical evidence, I dare not omit it. In these waters of the Opal Sea of Cretaceous times no reef-building corals lived—they could not. It was not that the waters were too charged with sediment, for corals throve in the preceding eras, and in the following Tertiary period. What a contrast to the Queensland coast of to-day, with its 1,200 mile long Barrier Reef ! It certainly looks as if the waters of the Opal Sea were too cool to allow of such growth, and when we remember that there was free ingress from the Antarctic we may see therein at any rate a partial explanation. Still, I would not trust to this alone.

32. Far stronger is the story told by the Tertiary

flora. Throughout this long era Australia was clothed with vegetation in which the oak (*Quercus*), the beech (*Fagus*), the elm (*Ulmus*) and the willow (*Salix*), and many another plant known to the dweller in temperate Europe and North America, took important roles. The climate must have been favourable to them. That it changed for the worse is proven without possibility of mistake, by the fact that they succumbed as the climate grew hotter and drier, and are no longer to be found in our native woods. The predominating feature of our Australian forests (except the true scrub, of which more hereafter), is the sombre Eucalyptus, the leaf-starved, phylloid-bearing Wattle (*Acacia*), and the leafless Casuarina—it is a shadeless forest.

33. On the other hand, the Tertiary forest was like the Forest of Arden or the Böhmer Wald, or the woodlands of Canada and the United States, full of umbrageous trees. There could have been no monotonous and tantalisingly impenetrable Mulga Scrub of thick-set bushy Eucalyptus; none of the dread Malee Scrub of prickly dwarf Acacia; still less was there the heart-rending Spinifex, covering hundreds of miles at a stretch with fixed bayonets of Triodia. The plains of the old lands were flower-decked savannahs, its lagoons were overhung with tree and bush whose deciduous leaves still lie in the fine ripple-marked silts that mark the old sites. A greater contrast between then and now can hardly be imagined. The deterioration of the Australian climate is no fancy of the philosopher: it is a truth stamped upon the rocks for all to read that list.

IV. THE IMPERFECTION OF THE GEOLOGICAL RECORD.

34. In the days when Darwin and Lyell wrote, the imperfection of the geological record could always be appealed to when evidence was not forthcoming. Even to this day some writers look to it in support of their views, as if it were some holy thing, some sacred mystic formula and specific, to be used in every emergency, and accepted as final, and without comment. Yet it is only an expession of ignorance, and its weight diminishes with every new discovery.

35. A theory might be true, and yet there be so many gaps in the evidence that it was unprovable, and it was lawful to say, "Wait for more evidence: it is the imperfection of the geological record that is in fault, not the theory." But if the theory be sound, each new discovery will narrow the gaps: if unsound it will widen them. It cannot be claimed that this test has worked out satisfactorily for many of the pet side-shows of the theory of Evolution.

36. For instance: our knowledge of fossil mammalia has vastly increased of late years, and many minor gaps have been filled in. But the greater gaps are more gaping than ever. We know, for example, a great deal about the fossil pedigree of horses: but we are farther off than ever from knowing the ancestry of the Equiidae. Still more remote seems any hope of perfecting the genealogical tree of the Mammalia. The old saw about Nature not moving by leaps seems to be losing its teeth.

37. When Wallace wrote his "Island Life" it was quite reasonable for him to hope, and write as if the future would reveal, the ancestors of our Marsupials in the rocks of Australia. The appeal to imperfection has lost its force to-day. We have explored the Australian and Tasmanian Tertaries pretty completely, and found them very rich in plant remains. Yet have we never found a trace of any land mammal at all. True, this is negative evidence: but if such creatures did not exist, what other than negative evidence is possible? Surely the negative evidence of every fisherman who has speared, or netted, or angled for, or poisoned, or dynamited fish in the Brisbane River is good evidence of the non-existence of trout in the stream!

38. When we get to Pliocene times, Marsupial remains are plentiful enough, showing there was no difficulty about their preservation. The fact is that the Marsupial was not in Australia; and as none of his remains are found elsewhere, and as he has no living representative outside the Australian area, the only logical inference is that he is of Australian origin, and of recent date at that. But we shall have to say more on this point presently. The American opposums, we shall see, are out of court.

39. The conclusion forced upon me is that both our

flora and fauna are of recent origin, that the Marsupials are quite new and unique, and that both are the direct consequence of the deterioration of climate which took place when the separation of the Australian Archipelago was superseded by the federation of the Australian Continent.

V. THE IMPERFECTION OF *THIS* RECORD.

40. This paper can only be a sketch of the evidence and of the conclusions at which I have arrived. The details are so numerous and voluminous that it will require a volume to set them forth, and this volume I shall undertake at once.

41. So much it is necessary to indicate, lest the reader imagine that because I deal chiefly with the Flora and Mammalia, I have not taken account of the evidence, for and aganist, which is deducible from the study of other forms of life.

42. In my forthcoming work I shall also deal with the views of other authors. There is not much to controvert. My explanation is mainly a constructive one, and only destructive on points of minor importance—points which do not affect the main conclusion—points which have always been felt to be difficulties.

VI. THE EXISTING AUSTRALIAN FLORA.

43. We are indebted to Sir J. D. Hooker for the first comprehensive view of the flora of Australia, and the long years that have passed since the masterly essay "On the Flora of Australia" was published in 1859, have not materially altered the views therein set forth.

44. There are several ways of looking at a flora, each in its way instructive, a few of which we will glance at, leaving particulars for my larger work.

45. There are some 10,000 known species of plants indigenous to Australia. They may be divided into Tropical and Temperate, and whereas elsewhere the tropical is always richer in species than the temperate flora, the reverse is the case in Australia, for over 6,000 species out of 10,000 belong to the temperate group. This in itself is sufficiently remarkable, but its significance only becomes clear when

we find that by far the greater number of the temperate forms are confined to a comparatively small area in Western Australia. Two-fifths of the genera and seven-eighths of the species are altogether confined to it. To this flora alone can the term Australian be accurately ascribed. It has spread, with modifications, all over the rest of the continent, but is there so altered, and so whelmed in the tropical flora, that it is quite subordinate. My friend, Mr. Cyril White, of the Botanic Department, Brisbane (who is himself unique as being of the fourth generation of botanists, his great-grandfather having been the first Australian Government Botanist, as his grandfather is still the oldest) has kindly undertaken for me the arduous task of working out the distribution of the entire Australian flora. Much interesting matter has come to light in the course of this research, but it must be relegated to my further work. Only broad facts, and only a selection of these can be given.

46. How entirely distinct the Queensland flora is from the West Australian is evidenced by the fact that of the 4,474 species named in Bailey's "Queensland Flora" only 620, or less than 14 per cent., occur in West Australia.

47. But mere numerical statements convey but an inadequate conception of the difference between the so-called Extra-tropical and the Tropical floras. It is the general facies that is most striking, and I can best illustrate it by a personal reference. I came to Queensland after spending years in the primeval forests of the Far East, and my first introduction to Australian forests was in the scrub of North Queensland. To me it was a revelation and somewhat of a disappointment. I knew, so far as the books and specimens can teach, what the peculiarities of the Australian flora were, but this Atherton scrub, this wild tangle of the Barron Gorge, was not Australian at all. It was the pure Asiatic "utan rimabau"—the deep forest—I had left in Borneo. The same tall trees with broad shade-giving leaves, the same climbing "rotan" (*Calamus*), and even the insects, gaudy *Ornithopteras* and royal purple *Eupleas*, met me on every hand. It all looked familiar. Some years afterwards, when I had grown accustomed to this flora, I entered W. Australia for the first time, landing

at Albany from S. Africa. What a revelation it was! At last I saw Australia-Vera: at last I was in a new and strange land: at last I knew and realised what I had only imagined I knew before. It is this great contrast that must be borne in mind.

48. I would rather substitute the terms *Oriental* and *Eu-Australian* for the two floras—the one is only tropical in that it is allied to that of tropical Asia, the other only temperate or extra-tropical because it is best marked in the West, which itself can only be called temperate geographically and euphemistically. The Oriental flora is more Asiatic in general aspect than in number of species actually common to Australia and Asia—there are about 620 flowering plants and 200 ferns specifically identical in the two areas. As might be expected, the most truly Asiatic part of Australia is the northern-coast line, the richest part of this is the region adjacent to Cape York peninsula, and the Asiatic plants have not crept far down the north-west coast. It is highly significant, too, that the aquatic Dugong and the aerial Fruit-bat or Flying Fox (*Pteropus*) have the same restrained limit westwards, though the former goes south along the east coast to Moreton Bay, and the latter as far as Tasmania.

49. No other portion of the world has such a remarkably differentiated flora. Not merely in the distribution of its species, but in the characters of the true Australian forms, which are profoundly modified to adapt them to the semi-arid conditions which now characterise the major part of Australia.

VII. THE FOSSIL FLORA.

50. Australia and Tasmania are rich in Tertiary deposits, and they have yielded a very rich harvest of plant remains, so that the imperfection of the geological record cannot be applied in this particular instance. We have ample evidence upon which to found a correct estimate of the nature of the Tertiary Flora of Australia. And as New Zealand, on the one hand, and Borneo, Java and Sumatra on the other, have yielded equally rich data, we have plenty of evidence as to the nature of the vegetation in the ages which preceded our own. True, we are not

always able to subdivide our Tertiary deposits with the minute accuracy attainable in Europe, and indeed in some cases it is still a moot point as to whether certain beds should not be relegated to the Upper Cretaceous. But, as a rule, it is not difficult to discriminate between Older and Newer Tertiary (*Eogene* and *Neogene*), and as a matter of fact this has only a subsidiary interest in our research. Suffice it that we can draw a fairly accurate picture of the Tertiary Flora.

51. When Wallace wrote his "Island Life," most of this evidence was unknown to him—much of it had not been published. It is chiefly to the researches of Messrs. R. M. Johnston and H. Dean, in our hemsiphere, and the Baron v. Ettinghausen in Europe, that our knowledge has become so complete, but many others have made valuable contributions.

52. Let us glance at this Tertiary flora, as represented from the Arctic regions to New Zealand, in all latitudes and all climates. The first thing that strikes us is the singular sameness of it all: singular not merely in possessing so many closely allied forms, but in being everywhere so utterly distinct from the flora of the present time. We look upon our Eucalypts, our Grevilleas and our Banksias, as strikingly Australian: but they had their representatives in Tertiary Europe and America. The oak, the beech, the elm, and the willow, are to us smybols of the woods and copses of the great Nearctic Region, yet they formed no inconsiderable proportion of the Tertiary flora of Australia. Even if we examine the Tertiary plants of such purely tropical places as Borneo, Java and Sumatra, we find it far less "tropical" than now, indeed, if we judge of climate by the plant remains we should hardly have guessed that these beds belonged to islands that are literally threaded upon the Equator. The Tertiary flora of the whole world was more uniform than now: and v. Ettinghausen has designated this the Universal Tertiary Flora.

53. That eminent authority thus sums up the case. "The Tertiary Flora of extra-tropical Australia (he might have included tropical also—S.B.J.S.) is as regards character, essentially distinct from the present living flora of Australia: nor does it closely resemble, in general, any other

living flora. On the other hand, it shows the mixed character of the Tertiary Floras in Europe, the Arctic Regions, North America, and probably all the Tertiary Floras. It has also much more similarity to the Tertiary Floras at present known than to the existing flora of Australia. *The characteristic plants of Australia are but feebly represented.*"

54. Space will not permit of details: for this my forthcoming book must be consulted. But this last conclusion, which I have italicised, enables us to put the botanical problem as never before. How comes it (1) that the present Flora is so utterly different from the Tertiary flora, and (2) how comes it that the feeblest part of the Australian Tertiary Flora has developed into the rich and unique Flora of the present? An answer will be given in the sequel.

VIII. THE PRESENT FAUNA.

55. It is chiefly upon the fauna of Australia that the idea has been founded that ours is an arrested continent, in which owing to long isolation, and consequent immunity from competition, have been preserved forms of life that elsewhere have succumbed or become modified in the struggle for existence. Among molluscs our Brachiopods, among fishes our Ceratodus and Cestraceon, for example, and above all our Marsupials are pointed to as lingering strains of the Mesozoic age—and in the pretty, banded, Myrmecobius we are asked to see the echo of the Microlestes that wandered by the waterside in old England when the Oolites were forming. No one ever seems to have doubted this, yet I believe I shall prove it to be an entirely erroneous assumption.

56. I cannot stop to work out the whole of our fauna. That must be recorded elsewhere. But as our Marsupials afford the strongest argument for the prevailing opinion, we will take them as a test. The assumption is based upon the fact that in Triassic and Jurassic times the only known mammals were small creatures which have been placed among the Marsupialia. Also that the aplacental character of these mammals shows that they are of very low—indeed the lowest—type of mammal. Let us see how far these assumptions are borne out by facts.

56. The essential feature of the Marsupialia is, of course, their aplacental development, and this clearly cannot be determined from fossil remains. Hence the marsupial affinities of fossil forms are inferred from certain peculiarities of the hard parts, which are alone preserved. Of these the most important are (1) a peculiar inflection of the jaw; (2) the character of the teeth; and (3) the presence of the so-called pubic bones. As a matter of fact the remains of pubic bones have never been found fossil in Mesozoic forms, and as this is the only certain proof of marsupial character, some doubt must always remain. Still, it may be admitted without damage to my argument that the Mesozoic forms were truly aplacental.

57. The modern Marsupialia are generally placed in two divisions—the *Diprotodonta*, with two prominent front teeth, and the *Polyprotodonta*, with many front teeth. The diprotodont forms are peculiar to Australia, none living elsewhere, and none having been found fossil outside Australia. True, an interesting series of forms have been recently disinterred from the Patagonian Tertiaries which were looked upon as possible ancestral forms of the Australian Marsupialia. But they turn out not to be Marsupial at all, their teeth being quite different in structure, and no pubic bones having been found, in spite of the fairly complete skeletons exhumed, they may be left out of our consideration. They seem rather to be Creodonts.

58. Outside the Australian Region the only living marsupials are the Opossums (*Didelphys*) of S. and N. America. They belong to the Polyprotodont division and their fossil remains are found in the Lower Tertiaries (Eocene) of Europe and N. America, but only in late Pliocene in S. America. None occur in the rich deposits of the Himalayas or Egypt. They certainly did not reach America via Australia, but most probably via northern Europe. They have no Australian representatives, the so-called Australian opossums being diprotodont. In Australia the Polyprotodonts are represented by several genera and species, but the mass of our Marsupials belong to the diprotodont division.

59. Now comes the important, and most singular fact in the distribution of the Diprotodont Marsupials. They

are exclusively Australian, none passing beyond the limits of the zoological region, nearly all of them confined to the continent itself and to Tasmania, and none reaching New Zealand. Not only are they thus strictly limited, but *not a single fossil mammal of any kind is found in any Australian deposit older than the Pliocene.* No such anomaly as this is known elsewhere: yet it has been entirely overlooked, and the tacit, or expressed, belief has arisen that our Marsupial fauna, with its vast development of types, comparable with almost the entire series of orders of the Placentaila, have been gradually evolved from primitive types whose remains will be found in our older Tertiary or Secondary rocks. There is not the slightest evidence in support of such a view: it is a pure assumption, diametrically opposed to facts.

60. So far as geology teaches us, and there is no other basis for a sound judgment, the Australian Mammalia (except the Cetacae and Phocidae) *appeared on the Continent in late Tertiary times, developed into the peculiar Australian forms with great rapidity, rapidly culminated in gigantic forms, and began to wane as rapidly.*

61. It is generally overlooked that our Mammalian fauna contains a large number of placental species. Our veteran osteologist, Mr. De Vis, so far as I know, is the only zoologist who has insisted on this fact. Taking the whole Australian Region, and citing only the genera given by Wallace in his "Geographical Distribution of Animals," we find thirty-five genera, ranging from the Primates and including almost every existing order. The number of Australian genera is nineteen. The Australian Marsupials include thirteen genera of Polyprotodonts and twenty of Diprotodonts. There are no less than eighty-two species of placental land animals recorded in my friend Ogilby's Australian list. This is no mean proportion. It is quite unfair to look upon Australia as devoid of the so-called higher forms of mammal.

62. If we omit the Dugong and the Seals, as hardly land animals, and the Dingo, which was probably introduced by man (perhaps very early man), we find these placental mammals are confined to the two orders (*Chiroptera* and *Rodentia*), which are best fitted to cope with

strenuous conditions of climate, the bats from their powers of flight, and the mice and rats, which are not only capable of thriving on dry food, but can do with a minimum of water —indeed some never drink at all. This is surely significant.

63. As every zoologist admits, our Marsupials and Monotremes taken together, and still more if the latter are left out, are not comparable with the individual placental orders, but represent them in bulk. Thus we have carnivora represented by such forms as Dasyurus, our Native Cats, herbivora by all kinds from the kangaroos of the plains to the tree-wallaby of N. Queensland and New Guinea; rodents are represented by the wombat, edentata by *Myrmecobius*, and so we may go on. Indeed the Metatheria (to use Huxley's terms) are comparable rather with the Eutheria than with any Family or Order thereof.

64. This indicates immense modification, and as it has been an axiom of most evolutionists that species are of such slow growth that even a geological era may not be long enough to produce one, we find even such careful reasoners as Wallace writing, "As, however, no other form than that of the Didelphyidae occurs there (Europe) during the Tertiary period, we must suppose that it was at a far more remote epoch that the ancestral forms of all the other marsupials entered Australia." Now this is not so much explaining a difficulty, as explaining it away. It assumes as true the slow evolution of species, and argues from this assumption that our diprotodont marsupials must have had a very remote ancestry a long way off. As far as real evidence goes, the assumption is as baseless as the deduction. The rocks are full of evidence of rapid origin of species: the outburst of Ammonites in the Jurassic, the irruption of all sorts of mammals after the close of the Cretaceous— one can find any number of cases in point—and never one to show anything else but rapidity as to the origin of species.

65. The simple facts are, that the Australian marsupials *did* come on suddenly: they did *not* enter Australia in the dim Mesozoic ages: they *never did* live elsewhere. This is what geology asserts: the other is what geologists assume. We have, on strict examination of the facts, arrived at an impasse, just as we did in the case of the Flora. Surely

there is a way out, without assuming what the facts deny: surely the facts themselves are fertile in suggestion.

66. Certain other points about our marsupials must be cleared up. First: they are said to be the lowest type of mammal: then because the earliest known mammals are (thought) to be marsupials, they are claimed as ancestors of the Australian types. Neither of these deductions has much more evidence in its favour than the gratuitous one that species are parlous slow in achieving stability.

67. The term "low" as applied to specific form, is fraught with dire risk of misrepresentation. Take the "highest" living mammal—dog, horse, monkey, what you will—and deliberately consider whether it is better adapted to its environment, displays finer mental or physical powers, than our Marsupials. On this view the term is simply nonsensical—the ways of no marsupial have ever originated such an adjective as "sheepish" or "piggish," and no one ever thinks of calling a fool a wallaby instead of an ass—and yet these, forsooth, be all higher types than anything we can show! It is not in physical or mental fitness that marsupials fall short.

68. But, says the systematist, it is in the mode of development that the marsupial comes short. Does it. Long ago, Sir R. Owen saw light in this darkness. He realised that in a land which was liable to periodic droughts, any mammal that brought forth its young, and cradled them in helplessness, would die out in the first long dry spell. The mother could not visit the distant water-holes and leave her helpless young behind. So, though Sir Richard had not the hardihood to put it so broadly, the mother kept her babies of portable size, built a pannier, and took the family about with her. Owen was laughed at: his shade may now begin to smile. Why, every bushman turns marsupial—only his pouch is his water-bag: being a man he is not so dependent upon the water-hole: he carries his water with him in his artificial marsupium.

69. The marsupial condition is eminently the best for the present Australian conditions—just as certainly as that it would not have been the best in the palmy days of the Opal Sea. Why should not our mammals have invented, or re-invented it? I don't pronounce one way or the other: either

suits my purpose. You may derive our stock from the ancestors of the few that extend beyond the continent into the further islands of the Region, if you like—they are all polyprotodont, by the way, and so presumably of ancient lineage. But I confess they look more like emigrants from Australia, than laggards in the great stream of immigrants—and they seem sadly out of place in the moist forests I know so well.

70. But our diprotodonts—our very own mammals—they are certainly of the soil, and now that Prof. King has shown us that they were originally placental mammals after all—that in their embryonic state they still show traces of placentation—my contention seems to be gathering shape. It turns out, too, that the despised Monotremes, the lowest of the low—have rather taken a down grade than remained in stolid indifference to advancement—for the baby Platypus has genuine teeth. I do not call this degeneration: I call it the acme of wisely directed Adaptation. So light seems to be breaking on this dark spot at last.

71. Europeans and Americans have been handicapped by early geographical training: they have been so accustomed to hear Australia called an island, and to see it tucked into the right-hand bottom corner of the map of Asia, that they unconsciously miss its continental magnitude. All travellers I have encountered have been amazed at the size of the Sunda islands, startled to find it takes half-a-day's good steaming to run up the Gulf of Manila: and not one in a thousand realises that the Barrier Reef, which only spans part of Queensland's coast, if shifted into the hemisphere which calls the tune for evolutionists to play, would reach from London to Gibraltar, or from New York into Dakota. They still think of an island in the terms of Robinson Crusoe, and tell us Australia is too small, and so had not room for sufficient rivalry, to grow good placentals in her own soil. This view has always led to Australian problems being misunderstood. So let me say once and for all, that on the continent of Australia there is scope sufficient for the working out of any problem in distribution or specific development.

IX. SOLUTION OF THE PROBLEM OF THE FLORA.

72. The solutions of the problems of our Flora and Fauna have, I trust, more than hinted themselves : but it is necessary to put the answers in definite language. The first question is, how comes it that the Australian Tertiary flora is so different from the present one ?

73. The reply to this should now be quite plain. At the close of the Cretaceous period, and far on into the Tertiary, the entire world-flora was less differentiated than at present, and Australia presented no peculiarity in this respect. That there was no great distinction between the floras of the east and west, is proved by the character of the fossil plants found in W. Australia, Victoria, N. S. Wales, Tasmania and Queensland.

74. Nor is this uniformity peculiar to the Tertiary flora. It becomes more evident, as our knowledge increases, that only in recent times—say from the Pliocene—has there been that great difference between the animals and plants which distinguishes one part of the world from another. In simple parlance, there was less of "the foreign" than now—the Palaeozoic and Mesozoic traveller would not have had the zest of fresh fields and pastures new (quotation dubious) for to him the molluscs and fishes, the crustacea and the reptiles, of the antipodes would have looked like home products. This great feature of general uniformity has not been sufficiently appreciated, and thanks are due to Mr. R. M. Johnston, of Tasmania, for insisting on its recognition. We are so accustomed to the idea that other places have other ways that we read the proverb *autres temps autres moeurs* back into geology, where it doesn't belong. There is something almost uncanny in crossing Europe and Asia amid the changing life, and dropping again upon most of the old English birds and butterflies in Japan, half round the globe : but it would not have excited a comment had we travelled with a Cretaceous Cook. So there is really nothing to explain as to why the Tertiary flora is so different from the present one.

75. The converse, why is the Australian present flora so much *more* different from the Tertiary than the floras of other places, is the true problem to solve. The answer is

that through the long Tertiary period the climate of Australia was deteriorating. The old universal flora had all the makings of the new flora in it—both the Orientalis and the Vera types—but when at last the Opal Sea became dry, only certain plants had adaptibility enough to battle with the increasing heat and decreasing moisture. The rest died.

76. But there was a great difference between Australia-Orientalis and Australia-Vera. The former, owing to its mountainous and coastal character suffered less in climate —it has continued to receive fairly, and in parts quite, abundant rain and so a portion of the old flora has been preserved, in spite of its inferior adaptibility. This is the so-called Tropical Flora which I prefer to call Oriental. It is as has been said, essentially Asaitic in facies, but the bulk is not specifically identical with the Asiatic flora—it is merely the tropical part of the Universal flora. This portion of our present flora, then, I look upon as a true survival.

77. Again Australia-Orientalis is still closely connected with New Guinea, and undoubtedly, was recently in direct physical continuity therewith. Hence there has been a real Asiatic immigration, And it is going on still.

78. I may remark, *en passant,* that it is considered as established that species become more vigorous, more able to cope with diverse conditions as they grow older—of course up to a certain age. Now if my contention be true, that our Flora as a whole is of modern date, the species should have comparatively small power of waging successful war against the sturdier denizens of botanically older lands. I do not lay much stress upon this, but we have learned to our cost, *e.g.*, in the Prickly Pear and Water Hyacinth (*Eichornia speciosa*), how alarmingly rapid is the spread of certain foreign species, and it is stated that no Australian introduced species has anywhere run riotously wild. If there is any truth in this, it tells in my favour. But I have seen *Mimosa pudica* and *Lantana*, both S. American forms, as is the Water Hyacnith, do just as much damage in places like Borneo and the Malay States, where the flora is assuredly as old as any. Also I do not know that any Australian plants likely to riot have been introduced into the northern warm-temperate zone, and garden flowers

assuredly have not established themselves, even in the rare cases in which they have become "escapees." I fear this is a bruised reed.

79. A point which will also appear in considering the distribution of our fauna is that if the true immigrant Asiatic plants are really of modern introduction, as compared with Oriental (tropical), we should expect not only to find them few in number, but gathered most richly about Cape York, and extending along the northern coast, and this is precisely what we do find.

80. The consideration of other features of the flora, such as the strange stream of northern-hemisphere sub-arctic plants that has so fascinated botanists and geologists, and the traces of Antarctic, African and S. American forms, must be left for another place.

X. SOLUTION OF THE PROBLEM OF THE FAUNA.

81. It has already been pointed out that while the Flora of Australia has been, for the most part, derived from the universal Flora which covered the earth in Tertiary times, and that but a small portion has been derived directly by immigration from Asia, the *Fauna* has no connection whatever with the geological history of Australia earlier than late Tertiary times. It now remains to clinch this argument with supplemental data.

82. If this contention be true, then the present distribution of the species should show evidence of their place of origin, much as the Asiatic portion of the Flora has been shown to do.

83. No one has a wider personal knowledge of the range of Australian animals than my friend the venerable Director of the Brisbane Museum, Mr. De Vis, whose researches into the palaeontology of the Marsupialia are so well-known. He has no doubt upon the question, and unhesitatingly declares for N. Queensland as the entrance gate: so do I.

84. Theoretically, on my view, we ought to find a very peculiar distribution. N. Queensland should be richest in species, and a rich stream, but of diminishing volume, should flow down the narrow area of ancient Australia-Orientalis from C. York to Tasmania. The broad land that was once Australia-Vera should show another, but less

rich culmination, and the intermediate, central area, the bed of the old Opal Sea, the newest and least rainy, should be meagrely blessed. This is actually the case.

85. Taking Ogilby's list, and supplementing it with Mr. B. H. Woodward's W. Australian list (Mr. O. Thomas' work unfortunately is not available in Queensland), the numbers as we travel along Australia-Orientalis from north to south are :—Queensland, 50 ; N. S. Wales, 43 ; Victoria, 35 ; Tasmania, 30.

86. If we travel east and west, from A. Orientalis, through the intermediate N. Territory and S. Australia to Australia-Vera in W. Australia, we find exactly the rise and fall in numbers the theory demands :—Queensland, 50 ; S. Australia, 32 ; N. Territory, 14 ; W. Australia, 38.

87. The W. Australian fauna has lately been studied most carefully, while the N. Territory is not so well worked, but though the numbers of species may need modifying, the relative proportions will remain as at present. My argument does not depend upon mere arithmetical accuracy: it is work for the actuary, not for the clerk.

88. The Bats and Rodents do not help us : they can get almost anywhere. Yet it is significant that the most highly modified bat, the Flying Foxes (*Pteropus*) are confined to Australia-Orientalis. W. Australia is in dread of their advent, and has by proclamation (1895) prohibited, "the introduction of Flying Squirrels, otherwise known as Flying Foxes, into the State." The Dugong is another case. Like the Pteropus, it might have been expected to have travelled far and wide—the ocean of water is as readily ploughed as the ocean of air, and both are abundantly victualed—yet it, too, is confined to Australis-Orientalis, never getting on to the west or even the north-west coast.

89. All this points conclusively to an Asiatic origin for our mammals, and no one seems to doubt the fact. But such a view is diametrically opposed to the descent of our fauna from a very ancient Australian ancestry : and is quite in harmony with my view of recent introduction. The crucial point is that there are no remains of land mammals in any of our pre-Pliocene rocks.

90. Whence then, came our Diprotodonts ? Well, there is another curious superstition rife among many

evolutionists, who seem to think every plant and animal must, like Ahaseurus, come from somewhere else. Even the poor Englishman used to be chased up into the Pamirs and called an Undivided Aryan: and Australia, being an island, could not possibly be allowed to score off her own bat. Yet why shouldn't she?

91. I take it that, as the geological evidence shows, in or about Pliocene times, Australia-Orientalis was again in land connection with Asia, *via* New Guinea (and perhaps Timor), and received plants and animals by that route. For the terrestrial mammals there was a vast new field, with no competitors save inoffensive lizards. It was an ideal land for the undisputed display of evolutionary force. But the new land was being converted into a veritable sand-bath, and though vegetation was plentiful, water was scarce and getting daily more capricious in its distribution, and being drained away by the Braystone.

92. The immigrants had to adapt themselves to the strange conditions, or perish. Doubtless many succumbed. The remainder became modified, and throve amazingly—and I believe the Diprotodont type was then evolved. Animal life literally ran riot, as is evidenced by the colossal and bizarre remains of these primeval marsupials. But, as in every other case where there has been a sudden development, they overshot the mark. The giants could not hold their own, and speedily died out, leaving only our Old Man Kangaroo, to suggest his Titan forbears.

93. Whether all the immigrants were placental and acquired marsupial habits, or whether some were already polyprotodont aplacentals, future research must determine. I incline to think both forms arrived, but hold the opinion very feebly, for there is weighty argument for the small marsupials which live in the extra-continental portions of the Region being rather gifts from "Marsupialia," than that they are the Trigonias and Lingulellas of the Class Mammalia.

94. The gap between the placentals and aplacentals is being rapidly closed in: and not as the Darwinian expected by making them the lowly promise of higher forms, but by placing them on an independent and co-equal base, as the latest of the new, and not the last of the old covenant.

It may be, too, that Huxley saw dimly the connection between the types when he pointed to certain abdominal ligaments in the dogs as possible homologues of the marsupial bones. But if the Metatheira have thus been rescued from a false position, the still more lowly Prototheria have been as wonderfully rehabilitated. These purely Australia-Orientalian monotremes are no survivals of the almost batrachian type, but highly modified descendants of true toothed forms. And they as yet have not reached Australia-Vera.

95. The palaeontological record, from the Cambrian upwards teems with denials of the shibboleth that *Natura non fecit per saltum*. Giant strides are a favourite pastime of hers: her cycles are not geared to one speed. She can linger over a form for ages, or expend her energy in outbursts of creative vigour. We thought, as we never saw her in her sportive mood, that she was coy or resting awhile. But De Vries has shown us it was not the restful sleep of Nature that lay upon the world, but that the darkness and the silence were in ourselves—our eyes were filmed: our ears had waxed dull. Species, true physiological species, and not mere morphological varieties are coming into daily existence. Darwin's artificial pigeons needed the strictest isolation, or intercrossing would blot them out: De Vries Aenotheras are free to all the winds that blow, and all the bees that gather pollen, and remain true to type, for they are barren to their unregenerate relations. We must begin *de novo*, almost, and read the story of Evolution by the daylight of facts, and put by as childish the poor torchlight of unsupported imagination.

XI. CERTAIN SIDE-ISSUES.

96. There are certain side-issues, of great importance, that space prevents me from dwelling upon. I hope to deal with them in a special work. Thus I have been, perforce, obliged to confine my remarks to the Australian Continent in its present delimitations. But Australian throes are not ring-fenced like her policy: they are world-wide in their significance. Australia did not spring adult and armed from any chaos. She is part and parcel of the planet, and has waxed and waned as its lands and seas

have grown and diminished. She was once farstretched westwards into the Indian Ocean. The depths of her west coast are but of yesterday—the movement is still going on. And she is connected with the upheavals and depressions of the great islands of the Indian archipelago, with the building of the mighty Himalayas.

97. The islands, great and small, included within the Australian Region of zoology, are genetically connected with the Australian continent. And so is far-off New Zealand.

98. Moreover, Australasia has, in times past, been linked with Antarctica, with S. Africa, and with S. America—but all before the eras this paper treats of. These, and other matters of equal fascination, I am reluctantly compelled to pass by in silence—for the present.

XII. CONCLUSIONS.

99. The conclusions I have arrived at, and I hope established, may be thrown into a few condensed paragraphs.

100. The views here set forth are an expansion of those propounded by Dr. A. R. Wallace in his "Island Life."

101. They differ fundamentally therefrom in recognising that the present Flora and Fauna are the result of the obliteration of the Opal Sea, and the consequent alteration of the Australian climate. Also in deriving both the Tropical and Extra-tropical Floras from the Tertiary universal Flora, and in allowing only a small proportion as true Asiatic immigrants. But chiefly in making all our land mammals to be late Tertiary forms ; not derived from pre-existing Australian forms, but entirely new species evolved to meet the new climatic conditions. The course of events was as follows :—

102. In Cretaceous times Australia was an archipelago, consisting of Australia-Orientalis on the east, a long mountainous island : of Australia-Vera to the south-west, with extension westwards beyond the present coast : and an intermediate island-studded sea, the Opal Sea.

103. At this time there were no land mammals, nor did any arrive till, in late Tertiary times, the Opal Sea was no more.

104. The climate was at first equable, mild, and the land copiously watered.

105. Steady elevation ensued, and went on through the Tertiary period, till the archipelago became the continent of Australia.

106. The climate rapidly deteriorated, and grew hot and dry, and the land became semi-desert, partly from diminished rainfall, partly from absorption by the Braystone.

107. Many of the original plants died out : the rest became profoundly modified. But as the old Australia-Orientalis suffered least climatic change, its plants retained more of their original character, and constitute the so-called Tropical or Asiatic flora. A small contingent of genuine Asiatic forms came across from Asia.

108. In late Tertiary times Australia was invaded by land mammals, mostly placental, with a few doubtful polyprotodont forms. The mass of the placentals developed aplacental characters and became our Diprotodonts, and perhaps, some became polyprotodont. The Bats and Rodents had no need to change, being sufficiently adaptable to thrive under the present climate.

109. Hence both our present Flora and Fauna are the direct result of the deterioration of climate consequent upon the obliteration of the Opal Sea. But whereas the Flora had a pre-existing basis to build upon, the land mammals were entirely new-comers. There being no competition, the rapid development of new types had every opportunity of taking place. The conditions were absolutely unique.

110. Hence, AUSTRALIA IS, IN REALITY, THE ONLY "NEW WORLD."

SYDNEY B. J. SKERTCHLY.

DESCRIPTION OF PLATES.

PLATE VI.—GEOLOGICAL.

In this plate the Cretaceous Beds are shown as exposed at the surface. They certainly underlie some of the dotted areas, and part of the Western Australian area marked Tertiary. How much of the sandy material of the Northern Territory and West Australia is of Tertiary age is not yet certain. The object of this map is simply to show how completely the Mesozoic and Tertiary Rocks cut the continent in two.

PLATE VII.—PRE-CRETACEOUS AUSTRALIA.

This map is founded on Plate I, and shows the geographical conditions which must have obtained prior to the infilling and upheaval of the Opal Sea-bed. The coast line should have been continued to include Tasmania. The coast of Australia-Orientalis most certainly extended further eastward than shown, and that of Australia-Vera further westward, but I have confined the outline to the present limit of the Continent.

PLATE VIII.—BOTANICAL.

This plate illustrates how completely isolated are the floras of the East and West, and how comparatively poor the central region is. The *Proteaceæ* were selected because they are a typical order of Australian plants, rich in genera and species, and not because they illustrate my theory better than other orders, or than the flora as a whole would do. Indeed the entire flora emphasises the peculiarity much more strongly than does any particular order of plants.

I have not made any scientific division of the continent, but if such divisions as those suggested by Prof. Baldwin Spencer were used, the facts would come out much more strongly. His Torresian largely coincides with my Orientalis, but he carries it along the Gulf coast, which belongs to the most recent instead of the most ancient part of Australia. This part of the Torresian area is characterised by true Asiatic species of plants—derived indeed from Asia.

The division of the Australian flora into Tropical and Extra-tropical, though real, obscures the facts of the origin of the plants. The Asiatic plants are all tropical, but then so are many of the true Australian plants, and the richness and wide-spread extent of the extra-tropical flora is simply due to the fact that in Tertiary times the only tropical habitat was in the northern portion of the narrow land of Australia Orientalis, while the greater part of Australia Vera, and the southern part of A-Orientalis (including Prof. Spencer's Bassian) was geographically extra-tropical and far wider in extent.

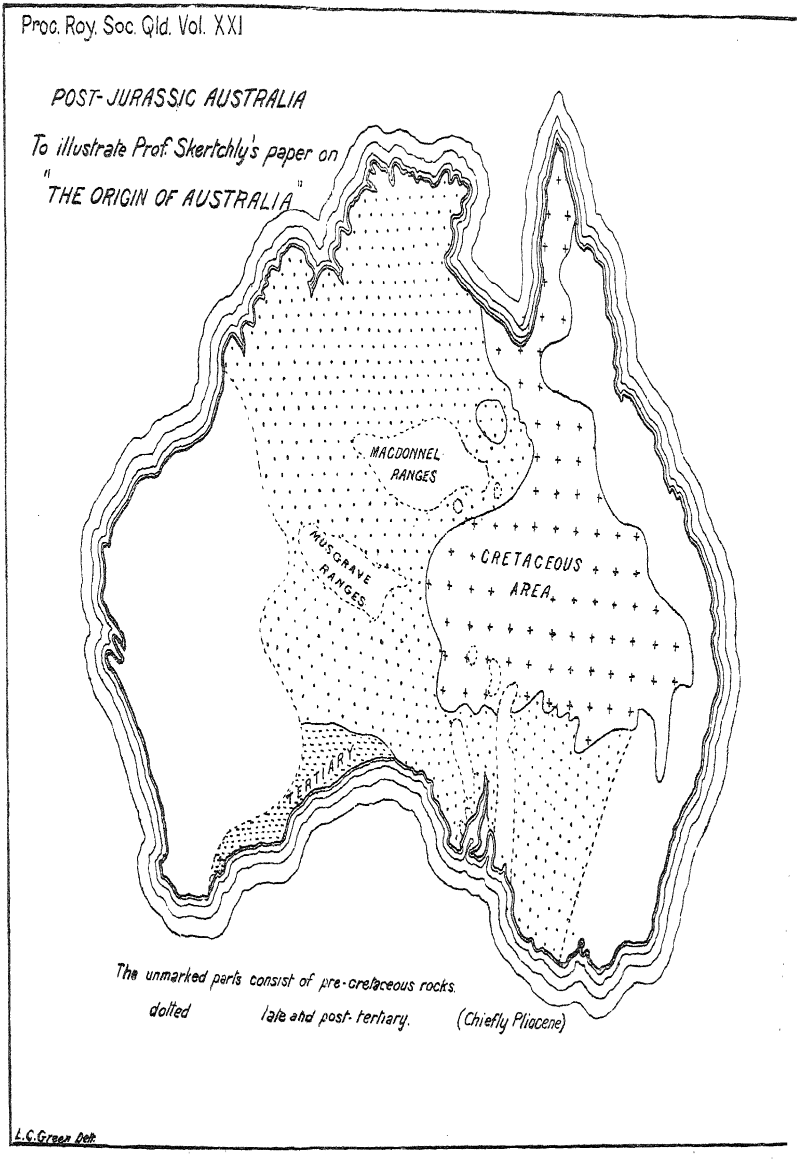
The following table gives the distribution of the whole of the Australian Proteaceæ:—

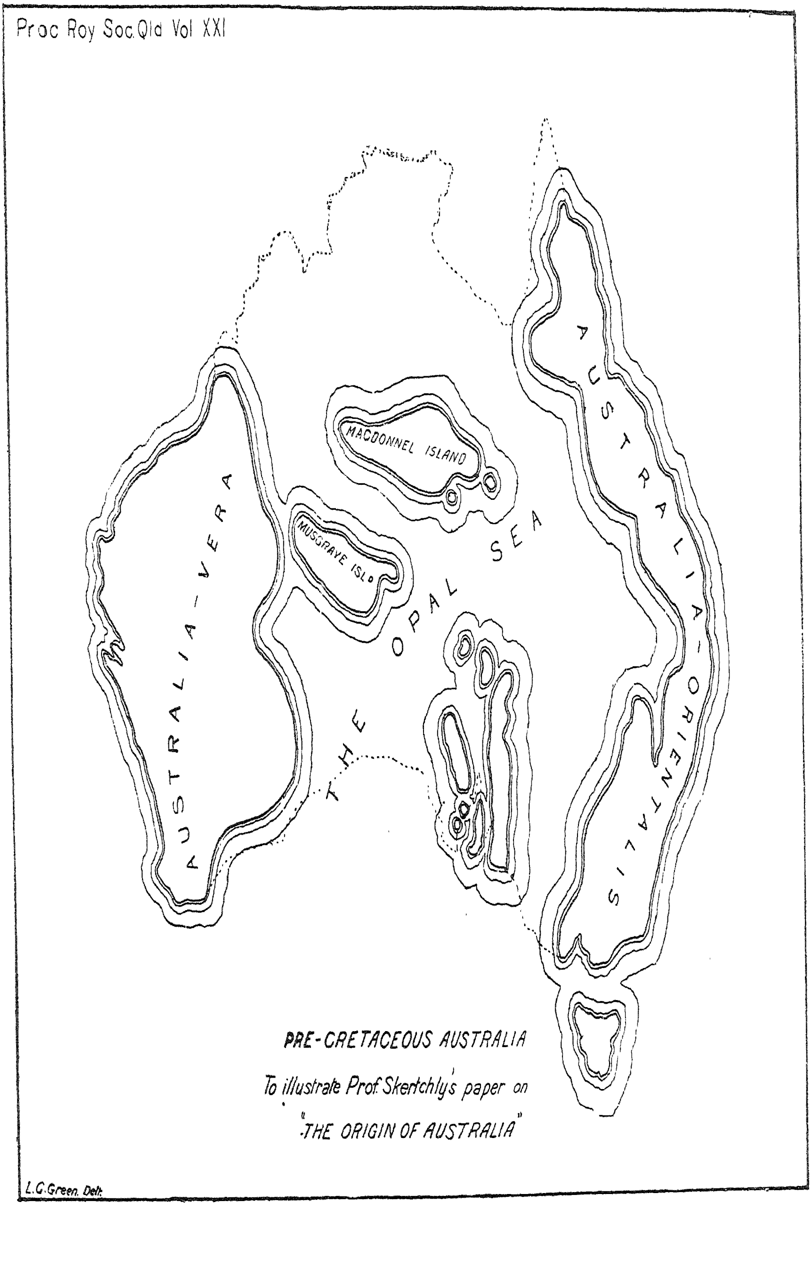
	W.A.	N.A.	S.A.	Q.	N.S.W.	V.	T.
Petrophila	33	0	1	4	3	0	0
Isopogon	25	0	2	2	4	1	2
Adenanthos	14	0	2	0	0	1	0
Simsia	5	0	0	0	0	0	0
Synaphea	8	0	0	0	0	0	0
Conospermum	27	2	1	2	7	3	1
Franklandia	2	0	0	0	0	0	0
Symphyonema	0	0	0	0	2	0	0
Bellendena	0	0	0	0	0	0	1
Agastachys	0	0	0	0	0	0	1
Persoonia	24	1	1	11	32	8	2
Macadamia	0	0	0	3	1	1	0
Helicia	0	1	0	0	7	4	0
Rcupala	0	0	0	0	1	0	0
Xylomelum	2	0	0	2	1	1	0
Lambertia	8	0	0	0	0	1	0
Orites	0	0	0	2	1	1	4
Kermadeckia	0	0	0	1	0	0	0
Hicksbeachia	0	0	0	1	0	0	0
Strangea	1	0	0	1	1	0	0
Grevillea	103	21	14	25	39	18	1
Hakea	73	7	10	18	14	11	6
Carnarvonia	0	0	0	1	0	0	0
Buckinghamia	0	0	0	1	0	0	0
Darlingia	0	0	0	1	0	0	0
Cardwellia	0	0	0	1	0	0	0
Stenocarpus	0	1	0	2	2	0	0
Lomatia	0	0	0	2	3	2	2
Embotherium	0	0	0	1	0	0	0
Telopea	0	0	0	0	1	1	1
Banksia	37	1	3	6	8	5	2
Dryandra	47	0	0	0	0	0	0

This list, though very remarkable, does not bring out the full force of the evidence; it does not show how few of the species are common to the West and East. I give below the range of the species of the genera, illustrated in Plate III:—

	Total.	Peculiar.	COMMON TO—			
			V.C.O.	V.C.	V.O.	C.O.
Petrophila	33	33	0	0	0	0
Isopogan	26	25	1	0	1	2
Adenanthos	15	13	0	1	0	1
Conospermum	27	25	0	0	1	2
Persoonia	25	25	0	0	0	2
Grevillea	103	99	5	4	1	13
Hakea	73	70	1	1	0	10
Banksia	37	37	0	0	0	2
Dryandra	47	47	0	0	0	0

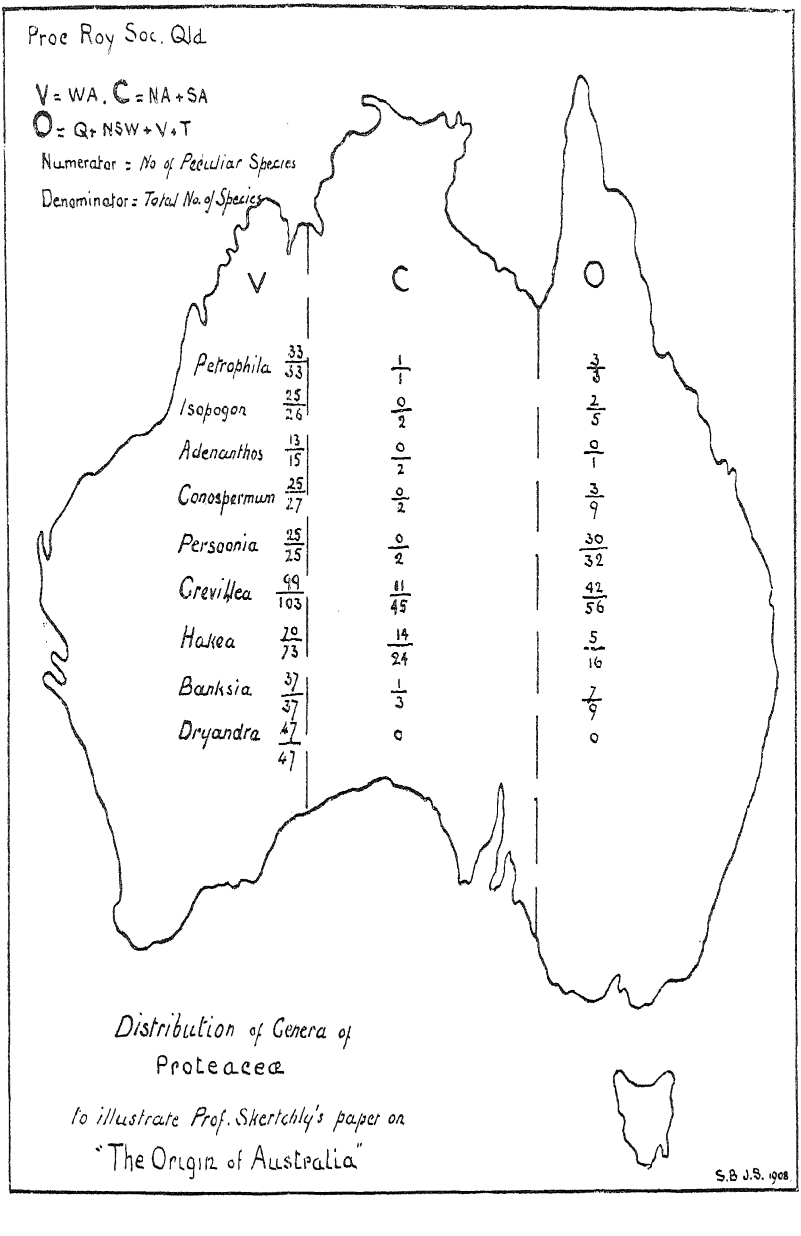
v-Vera, c-Central, o-Orientalis.


Proc. Roy. Soc. Qld. Vol. XXI
POST-JURASSIC AUSTRALIA
To illustrate Prof. Skertchly's paper on
"THE ORIGIN OF AUSTRALIA"
MACDONNEL RANGES
MUSGRAVE RANGES
CRETACEOUS AREA
TERTIARY
The unmarked parts consist of pre-cretaceous rocks.
dotted late and post-tertiary. (Chiefly Pliocene)
L.C. Green Delt.



PRE-CRETACEOUS AUSTRALIA

To illustrate Prof. Skertchly's paper on "THE ORIGIN OF AUSTRALIA"


Proc Roy Soc. Qld.
V = WA. C = NA + SA
O = Q + NSW + V + T
Numerator = No of Peculiar Species
Denominator = Total No. of Species
V
C
O
Petrophila 33/33 1/1 3/3
Isopogon 25/26 0/2 2/5
Adenanthos 13/15 0/2 0/1
Conospermum 25/27 0/2 3/9
Persoonia 25/25 0/2 30/32
Grevillea 99/103 11/45 42/56
Hakea 70/73 14/24 5/16
Banksia 37/37 1/3 7/9
Dryandra 47/47 0 0
Distribution of Genera of Proteaceæ
to illustrate Prof. Skertchly's paper on "The Origin of Australia"
S.B J.S. 1908

DESCRIPTIONS OF NEW QUEENSLAND FISHES.

By J. DOUGLAS OGILBY.

Read before the Royal Society of Queensland, December 14th, 1907.

In the paper which I have the honor of presenting to your Society to night there will be found detailed descriptions of seven undescribed fishes from our coast, namely—1, the "slender dog-shark" (*Scoliodon jordani*) from the snapper banks outside Moreton Bay; 2, Howes' needle-fish (*Tylosurus impotens*); 3, the "long-beaked gar-fish" (*Hemirhamphus welsbyi*); 4, the "sombre leather-jacket" (*Pseudomonacanthus melanoides*); 5, the "white-dotted grouper" (*Epinephelus raymondi*), from Moreton Bay; 6, the "small-toothed jew-perch" (*Pseudomycterus macculIochi*), from the Logan River; and 7, the "Queensland bellows-fish" (*Macrorhamphosus gallinago*) from the Tweed Heads.

In addition I have the pleasure of adding to the Australian fauna the showy clupeid known as the "lady-fish" (*Albula vulpes*), a fine specimen of which was captured along with sea mullet (*Mugil dobula*) at Southport on the 13th of June, and having fortunately come under the notice of my colleague, Mr. A. Raymond Jones, was purchased by him and presented to the Museum of the Amateur Fishermen's Association. A few days later a much larger example was taken at the same place, but falling into a dealer's hands was cut up and sold by the pound.

On the 26th of May, the members of the Brisbane Snapper Club were astonished to catch, on the large hooks and baits in use for snapper and kindred fishes, quite a number of mackerel (*Scomber australasicus*); this is the most northerly point at which this species has been obtained and forms a new record for Queensland. These shoals weer

feeding at the bottom and were accompanied by droves of sharks (*Carcharias melanopterus*), numbers of which were captured.

From an examination of several specimens I find that de Vis' *Crossorhinus ornatus* is a valid species closely allied to *Orectolobus japonicus*, Regan. Its correct title is *Orectolobus ornatus*.

SCOLIODON JORDANI *sp. nov.*

Slender Dog-shark.

Body slender and subfusiform, its width $\frac{7}{8}$ of its depth, which is $10\frac{3}{5}$ in the total length. Head strongly depressed, its depth immediately in front of the gill-slits $1\frac{4}{9}$ in its width, which is $2\frac{1}{4}$ in its length. Length of head $1\frac{3}{8}$ in that of the trunk and $\frac{1}{5}$ of the total length. Snout produced and pointed, its length $2\frac{4}{9}$ in that of the head. Space between the outer angles of the nostrils a little more than that between the inner angle and the tip of the snout, which is $1\frac{5}{7}$ time its distance from the mouth; internasal space $1\frac{1}{10}$ in the width of the mouth, which is but little ($\frac{1}{6}$) more than its ramal length, $\frac{5}{7}$ of the length of the snout, and $3\frac{3}{8}$ in that of the head; tip of mandible rounded, not extending forward to the level of the anterior border of the eye; outer labial groove very short, directed outwards at a right angle to the jaw and $\frac{1}{9}$ of the space between the eye and the mouth; no inner groove. Eye a little nearer to the first gill-slit than to the extremity of the snout, its longitudinal diameter $\frac{1}{8}$ of the length of the head. Interorbital region convex, its width $2\frac{9}{10}$ in the length of the head. Branchial region $1\frac{7}{9}$ time the diameter of the eye; gill-slits narrow, the 5th $\frac{5}{6}$ of the 1st and $\frac{3}{4}$ of the 4th, which is the widest though not so wide as the eye. Length of head and trunk about $1\frac{1}{10}$ in that of the tail. First dorsal fin inserted much nearer to the ventral than to the pectoral, its distance from the tip of the snout rather more than $\frac{1}{3}$ of the total length; anterior border of fin undulose, its outer angle rather sharply rounded; outer border vertical in front, deeply emarginate behind, its posterior angle produced and acutely pointed, not quite reaching to the vertical from the origin of the ventral; length of hinder border rather less than half the base, which is $1\frac{1}{5}$ in the vertical height of the

fin : second dorsal very small, inserted much nearer to the tip of the tail than to the origin of the first dorsal, the length of its base $3\frac{1}{5}$ in that of the first dorsal and nearly $\frac{1}{2}$ of the posterior border. Anal fin inserted much nearer to the caudal than to the ventral and wholly in front of the second dorsal, its posterior border much shorter than that of the second dorsal and a little less than the basal length, which is $2\frac{2}{5}$ in its distance from the precaudal pit. Caudal fin long, its upper border $1\frac{1}{10}$ time the length of the head and $4\frac{1}{2}$ in the total length ; terminal border convex, $2\frac{1}{4}$ times the lower border behind the notch, its upper angle acute ; descending lobe of lower border well developed and subfalciform, originating slightly in advance of the upper precaudal pit ; its anterior border $2\frac{1}{6}$ in the space between its origin and the notch, which is $1\frac{2}{5}$ time its distance from the origin of the anal. Pectoral fin moderate, extending when appressed to below the origin of the first dorsal, its anterior border linear, except at the extreme tip where it is bent downwards, its upper angle pointed ; outer border emarginate, the lower angle rounded ; posterior border sublinear ; width of fin from outer inferior angle to middle of anterior border $\frac{4}{5}$ of its outer border. Ventral fin rather small, its origin $\frac{1}{5}$ nearer to the anal than to the pectoral all the edges linear, the angles obtusely pointed. Dark ashy blue above, gray beneath : pectoral and ventral fins outwardly edged with ash-gray : iris white. (Named for Professor David Starr Jordan, of the Leland Stanford Junior University, in remembrance of his flying visits to Brisbane in May and June, 1907).

Described from an adult male, 860 millimeters in length, obtained on the outer Caloundra Bank in 25 fathoms on the 26th of May, 1907, by Mr. J. Daly, by whom it was presented to the A.F.A.Q. Museum ; Cat. No. 664.

BELONIDÆ.

TYLOSURUS IMPOTENS, *sp. nov.*

Howes' Needle-fish.

D. 20 ; A. 19 or 20 ; P. 13. Body subfusiform, its depth equaling the distance between the preopercular border and the middle of the eye and from 14 to 15 in the length of the body. Width of head equal to its depth and rather

more than $\frac{1}{5}$ of its length, which is $\frac{1}{3}$ of that of the body. Postorbital portion of head $2\frac{1}{3}$ in the preorbital portion which is $4\frac{3}{4}$ in the length of the body. Jaws moderate and stout, the maxillary not entirely concealed when the mouth is closed; enlarged teeth strong but rather short; tongue ciliate. Upper surface of head with a wide and rather deep median groove; supraciliary and parietal regions partially striated. Diameter of eye $1\frac{1}{3}$ in the interorbital width and $2\frac{1}{2}$ in the postorbital portion of the head. Scales very small; cheeks and anterior half of cephalic groove scaly; opercles naked. Dorsal fin originating above the 4th or 5th anal ray, the height of the 2nd ray equal to its distance from the base of the 11th; posterior rays not produced; the last not reaching to the base of the caudal. Anal fin about as long as the dorsal, its anterior rays $\frac{1}{3}$ longer than those of that fin and reaching to the base of its 14th ray. Caudal fin feebly emarginate, its lower lobe as long as the head behind the middle of the eye; caudal peduncle depressed, as wide as deep, with scarcely a trace of a lateral keel. Pectoral fin long and pointed, equal to the head behind the middle of the eye and $8\frac{1}{2}$ to $9\frac{1}{2}$ in the length of the body. Ventral fin inserted midway between the root of the caudal and the middle of the eye, not so long as the postorbital portion of the head, and $12\frac{2}{3}$ in the body length. Dark green above, sides iridescent silvery, below white; dorsal and caudal fins dull green, with dusky borders; outer half of pectorals blackish; middle ventral rays yellowish: iris silvery, tinged above with pale yellow. (*impotens*, headstrong).

Type in the collection of the Amateur Fishermen's Association of Queensland.

Total length 800 millimeters.

Coast of Southern Queensland.

Howes' Needle-fish differs from *Tylosurus macleayanus* in the larger eye, the incomplete recession of the maxillary, the depth of the cephalic groove, and the shorter posterior dorsal rays; from *T. groeneri* in the depth of the cephalic groove, the smooth tongue, the broader peduncle, and the longer pectoral fin.

Described from two specimens, measuring respectively 540 and 580 millimeters, taken in Moreton Bay, and pre-

sented to the A.F.A.Q. Museum by Mr. Harry A. Howes; Cat. No. 537.

The genus *Tylosurus* Cocco, may be conveniently subdivided as follows :—

STENOCAULUS : Body short and deep, strongly compressed, the caudal peduncle without a trace of a lateral keel. Type—*Belone krefftii*, Günther. (στενός. narrow; καυλός, a stalk).

TYLOSURUS : Body long, slender, and subcylindrical, the caudal peduncle without or with but a slight trace of a lateral keel. Type—*Tylosurus cantrainii* Cocco. τύλος, callus; ὀυρά, a tail).

EURYCAULUS : Body short and broad, the caudal peduncle strongly depressed, with a wide sharp-edged lateral keel. Type—*Belone platyura* Bennett. (ἐυρύς, wide; καυλός, a stalk).

EXOCŒTIDÆ.

HEMIRHAMPHUS WELSBYI *sp. nov.*

Long-beaked Gar-fish.

D. 13; A. 12 or 13; Sc. 50 to 52-6. Body robust, its width $\frac{3}{4}$ of its depth, which is $8\frac{1}{5}$ in its length. Length of head $2\frac{2}{3}$, of predental portion of the lower jaw, which is $\frac{1}{7}$ longer than the rest of the head, $4\frac{9}{10}$ in that of the body. Premaxillary plate wider than long. Diameter of eye equal to or a little less than the interorbital width and $\frac{2}{3}$ of the postorbital portion of the head. Dorsal and anal fins scaleless, the former originating far in advance of and $1\frac{3}{5}$ time the length of the latter; last dorsal ray produced, not reaching to the base of the caudal. Caudal fin forked, the middle rays $\frac{5}{6}$ of the diameter of the eye and $4\frac{4}{5}$ in the lower lobe, which is $5\frac{2}{3}$ in the length of the body and $1\frac{1}{9}$ in the predental portion of the lower jaw. Pectoral fin with 12 rays as long as the head behind the angle of the mouth. Ventral inserted midway between the root of the caudal and the middle third of the pectoral, its length $1\frac{7}{8}$ in that of the head from the tip of the premaxillary plate; inner ray produced, not reaching to the vent. Back dark green; sides with a conspicuous silvery band, which is widest below the dorsal fin, tapers towards either extremity, and is bordered above by a blue line; lower parts

pearly white: anterior dorsal rays, outer and middle caudal rays, upper pectoral rays, and middle ventral rays dusky. (Named for Mr. Thomas Welsby, President of the Amateur Fishermen's Association, and an enthusiastic supporter of all scientific work connected with marine zoology).

Type in the collection of the Amateur Fishermen's Association of Queensland; Cat. No. 648.

Length to 400 millimeters.

Coast of Southern Queensland.

Described from eight examples, measuring from 280 to 400 millimeters, obtained in Moreton Bay during June, 1907, and presented to the Museum by Messrs. Thomas Welsby and Joseph Basile. They were very abundant until towards the close of the succeeding month, when they disappeared, and have not since been seen in our shops or market.

MACRORHAMPHOSIDÆ.

MACRORHAMPHOSUS GALLINAGO *sp. nov.*

Queensland Bellows-fish.

D. iv 11; A. 16. Depth of body $3\frac{5}{8}$ in its length, $1\frac{5}{7}$ in the length of the head, and $1\frac{9}{10}$ in the trunk and tail. Length of head $2\frac{1}{8}$ in that of the body. Eye large, its diameter $3\frac{1}{4}$ in the length of the snout and rather more than $\frac{1}{5}$ of that of the head; snout $3\frac{1}{5}$ in the length of the body. Interorbital region convex, its width $\frac{3}{4}$ of the diameter of the eye. First transverse branch of the lateral line with its inferior portion very short and bent strongly forward so as to form an angle of about 15° with the horizontal branch. Second spine of first dorsal fin long, strong, and posteriorly serrated, extending backwards when depressed to the anterior fourth of the caudal fin, its height $3\frac{1}{8}$ in the length of the body and $1\frac{5}{8}$ in that of the trunk and tail; its origin is midway between the base of the middle caudal rays and the posterior border of the eye; soft dorsal fin acutely pointed, its base $\frac{2}{3}$ of its height and $\frac{3}{7}$ of the base of the low anal. Caudal emarginate, $2\frac{1}{8}$ in the length of the snout. Pectoral fin pointed, with 14 rays, the upper the longest, $\frac{1}{2}$ of the snout. Brick red above; cheeks, opercles,

and abdominal region violet bronze ; middle of sides silvery : fins yellow : iris silvery (*gallinago*, a snipe).

Type in the collection of the Amateur Fishermen's Association of Queensland.

Total length 123 millimeters.

Described from a fine specimen obtained at the Tweed Heads by Mr. Dallas Beal, in May, 1907, and kindly presented by him to the Association's Museum.

This species is certainly distinct from Waite's *Macrorhamphosus elevatus*, from which it may be distinguished by the fewer dorsal and anal rays ; the more elongate body, the shorter second dorsal spine, which originates much more anteriorly than in southern specimens, in which—according to Waite's figure—the origin is equidistant from the eye and the *tip* of the middle caudal rays, etc.

FAMILY SERRANIDÆ.

EPINEPHELUS RAYMONDI *sp. nov.*

Dotted Grouper.

D. xi 17 ; A. iii 9 ; Sc. 19-94-32. Depth of body $2\frac{4}{5}$, length of head $2\frac{5}{7}$ in the length of the body. Snout $\frac{1}{7}$ longer than the diameter of the eye, which is $4\frac{2}{7}$ in the length of the head. Interorbital region feebly convex, its width $7\frac{1}{2}$ in the head. Nostrils approximate, the anterior valvular. Lower jaw slightly projecting ; maxillary extending to below the posterior border of the eye, the width of its distal extremity rather more than half the diameter of the eye. Teeth in two series on each side of the mandible ; canines small. Vertical limb of preopercle convex, evenly and finely serrated, the angle rounded and armed superiorly with four stronger serræ, the lower limb entire ; opercular spines equidistant, the lower much further back than the upper ; opercular flap obtusely pointed, its upper border linear. Scales mostly ciliated, those of the head (except the opercle), the nape and a gradually narrowing area of the back from an eye's width behind the opercular flap to the base of the 8th dorsal spine, and the pectoral and thoracic regions deeply imbedded. Gill-rakers 12 on the lower branch of the anterior arch, the longest $\frac{3}{8}$ of the diameter of the eye. Dorsal fin originating a little in advance of the base of the pectoral

(above the base of the middle opercular spine); 4th, 5th and 6th rays highest, $\frac{3}{7}$ of the length of the head and as high as the middle soft rays; last spine shorter than the penultimate, $\frac{3}{10}$ of the head. 2nd anal spine a little higher than the 3rd, $2\frac{6}{7}$ in the length of the head. Caudal fin rounded, $\frac{1}{4}$ of the length of the body. Pectoral rounded, with 17 rays, $\frac{3}{4}$ of the length of the head. Ventral much shorter than the pectoral, reaching to the vent, its length $1\frac{5}{8}$ in that of the head. Pale lilac, each scale of the body and opercles with a central white dot; body with a series of dark blotches which form six irregular bands running obliquely forward from the dorsal profile: soft dorsal and anal fins lilac with a broad purplish basal band; caudal tipped with purple; pectoral with a reddish brown basal spot; ventral marbled light and dark lilac. (Named for my friend and colleague, Mr. Audrey Raymond Jones, without whose hearty cooperation I would have found it well nigh impossible to carry out successfully my multifarious duties to the Association).

Type in the collection of the Amateur Fishermen's Association of Queensland; Cat. No. 678.

Total length 203 millimeters.

Coast of Southern Queensland.

Described from a specimen captured by Mr. C. Dahl at Cape Moreton, in May, 1907, and presented by him to the Association's Museum.

SCIÆNIDÆ.

PSEUDOMYCTERUS *gen. nov.*

Body elliptical, strongly compressed dorsally. Scales rather large, adherent, ciliated, with a wide spinulose submarginal band. Lateral line complete, extending on the proximal half of the caudal fin, the tubes straight with a single pair of predistal opposing tubules, not reaching to the border of the scale. Head rather small, scaly except the anterior half of the snout and preorbitals. Mouth inferior, the snout obtuse, projecting well beyond the upper jaw and bearing on its antero-inferior margin four short broad papilliform processes, which separate and conceal five large pores; maxillary entirely concealed beneath

the preorbital when the mouth is closed; lower jaw included; a large open mental pore. Jaws with a band of minute teeth; no enlarged teeth; vomer, palatines, pterygoids, and tongue toothless. Nostrils separate, the posterior the larger, rounded, semivalvular, and approximate to the orbit. Eyes of moderate size, mostly anterior and supero-lateral. Preorbital deep and entire; vertical limb of preopercle with a narrow, crenulated, membranaceous border; opercle with a short spine. Two dorsal fins, connected at the base, with x, i 29 rays, the spinous portion much shorter and higher than the soft, its rays flexible: anal fin short with ii 7 rays, the second spinous ray strong; vertical fins with a low basal scaly sheath, and a series of small scales behind each soft ray: caudal fin large and cuneate, mostly scaly: pectoral fin well developed, asymmetrical, with 18 rays, the upper middle ones the longest: ventrals inserted behind the base of the pectorals, close together, with i 5 rays, the first soft ray the longest and terminating in a filament. Gill-openings wide; gill-membranes separate, free from the isthmus; seven branchiostegals; pseudobranchiæ well developed; gills four, a slit behind the fourth; gill-rakers short and spinulose; first, second, and fourth upper pharyngeals armed with small sharp teeth, the inner row of which is somewhat enlarged; third pharyngeal enlarged, with strong conical teeth; lower pharyngeals separate, with five series of teeth, the inner strong, the others gradually diminishing in size. Air bladder large, without lateral fringes, expanded in front, pointed and extending well beyond the vent behind. Stomach siphonal; seven short pyloric appendages; intestine with two convolutions. (ψεῦδος, false; μυκτηρ, nostril; the anterior nasal flaps and pores having the appearance of supplementary nostrils).

Coast of Queensland.

In the feebleness of its dentition this genus differs from all the other Australian sciænids, and approaches the American genus *Leiostomus*,* from which, however, it may be distinguished by the permanency of the mandibular teeth, the shorter anal fin, the cuneate caudal, and the acute lower pharyngeal teeth.

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* Lacépède, Poiss., iv., p. 439, 1802.

PSEUDOMYCTERUS MACCULLOCHI *sp. nov.*

Small-toothed Jew-fish.

D. x, i 29; A. ii 7. Sc. 7—58—14; L. l. 46. Dorsal profile much more arched than the ventral; depth of body $3\frac{1}{4}$ in its length. Upper profile of head obliquely linear, its length $3\frac{1}{2}$ in that of the body. Snout obtuse and overhanging, rounded above, $\frac{1}{3}$ more than the diameter of the eye, which is $4\frac{1}{3}$ in the length of the head. Interorbital region convex, its width $3\frac{2}{5}$ in the head. Maxillary extending to below the middle of the eye, the width of its distal extremity $2\frac{1}{2}$ in the diameter of the eye. Depth of preorbital $1\frac{2}{7}$ in the eye. Second dorsal spine highest, $1\frac{2}{5}$ in the length of the head, and $1\frac{1}{2}$ time the height of the soft dorsal. Anal fin originating below the 13th dorsal ray, its 2nd spine of moderate length, $1\frac{1}{5}$ time that of the snout, and $1\frac{1}{2}$ in the 1st ray, which is much lower than the spinous dorsal. Caudal fin $3\frac{4}{5}$ in the length of the body; least depth of peduncle about 3 in the depth of the body and equaling the 2nd anal spine. Pectoral fin with 18 rays, reaching to the 12th scale of the lateral line, and $4\frac{1}{5}$ in the length of the body. Ventral fin not quite so long as the pectoral, extending midway between its origin and the base of the 4th anal ray. Gill-rakers 5 + 10, the longest about $\frac{1}{6}$ of the diameter of the eye. Silvery, everywhere so clouded with densely packed brown spots as quite to obscure the ground-color: vertical fins darker than the body, except the base of the spinous dorsal, which is dull blue. (Named for Allan Riverston McCulloch, a rising young Australian biologist).

Type in the collection of the Amateur Fishermen's Association of Queensland.

Total length 285 millimeters.

Described from a specimen caught in September last in the Logan River by Mr. C. Harris, and presented by him to the Association's Museum.

On being shown the fish, Mr. W. Nicklin states that to the best of his belief it is the same species as was common in the Brisbane River many years ago, and suddenly disappeared. The same habit has also been noticed in the now common "perch" of our fishermen, which, however, is a true *Sciæna*

MONACANTHIDÆ.

PSEUDOMONACANTHUS MELANOIDES *sp. nov.*

Sombre Leather-jacket.

D. 34; A. 29. Skin velvety, without distinct scales. Depth of body $\frac{1}{2}$, length of head (to upper angle of the gill-opening) $\frac{1}{3}$ of the length of the body. Snout with the upper profile concave, its length $3\frac{3}{4}$ in that of the body and more than thrice the diameter of the eye, which is $\frac{1}{4}$ of the length of the head, $\frac{5}{6}$ of the interorbital width, and is situated midway between the base of the dorsal spine and the upper angle of the gill-opening, and also between the tip of the snout and the first dorsal ray. Gill-opening below the posterior half of the eye, extending obliquely backward from in front of the upper angle of the pectoral, its length rather less than the diameter of the eye and equal to its distance from the eye. Dorsal spine originating above the middle of the eye, its height equaling the length of the snout, and rather less than its distance from the soft dorsal, which originates somewhat nearer to the tip of the snout than to that of the caudal fin: soft dorsal low and rounded, lower than the anal, the highest rays of which are $\frac{3}{10}$ of the length of the head; the anal originates well behind but is conterminous with the soft dorsal. Caudal rounded, $5\frac{1}{5}$ in the length of the body; caudal peduncle strongly compressed, its least depth $\frac{1}{2}$ of the length of the snout. Pectoral short, with 12 rays, rather more than $\frac{1}{2}$ the snout. Black, with a broad silvery band across the chin, midway between the tip of the mandible and the pectoral fin: soft dorsal, anal, and pectoral fins hyaline; caudal blackish (*melas*—from μέλας, gen. μελανος, black—an allied species; εἶδος, resemblance).

Type in the collection of the Amateur Fishermen's Association of Queensland.

Total length 71 millimeters.

Coast of Southern Queensland.

Described from a specimen obtained at Cape Moreton, in May 1907, by Mr. James Palmer of Bulwer, to whom the Association is indebted for it.

Note on some fishes which fell during the thunder-storm on the 7th instant.—On the 5th March, 1906* I had the privilege of reading before this Society a note on the phenomena commonly known as "showers of fishes." In that note I showed that to my own knowledge two at least of our common creek forms were liable to be victims to these caprices of the elements, these being the "carp gudgeon" (*Carassiops compressus*) and the "firetail" (*Austrogobio galii*). I have now the pleasure of adding to these a third species, namely, the "trout gudgeon" (*Krefftius adspersus*). On the morning of Monday, October 7th, after the phenominal hail- and thunder- storm of the preceding night, Mr. W. Adams, of Kelvin Grove, noticed numbers of these fishes lying dead in Victoria Park, which could have come to their untimely end by no other means. One circumstance, however, tends to exalt the present occurrence above the two which I have previously recorded, for whereas in those the specimens collected were small, measuring less than an inch and a half, and weighing but a few grains, in this case the larger of the pair secured by Mr. Adams, and kindly forwarded by him to the Amateur Fishermen's Association Museum, has a total length of 98 millimeters (close on 4 inches), and weighs 125 grains, or almost exactly half an ounce. That fishes of such a size and bulk could be whirled up into the air and carried along for a considerable distance shows the exceptionally violent character of that particular storm.

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* Proc. Roy. Soc. Queensl., xx, 1906, p. 28.

INSECTS AND DISEASE.

By Dr. A. JEFFERIS TURNER,

M.D., LOND., D.P.H., CAMB.

A Paper read before the Royal Society of Queensland, on January 27th, 1908.

CASTING about for some topic on which to address you, it has occurred to me to chose for my subject the relationship between insects and disease, or insects as disease carriers. I must, however, disclaim any attempt to treat this subject in an exhaustive fashion. Of recent years, this department of science has grown too large to be adequately dealt with in my time-limit. Instead of attempting a bare summary of the whole ground, I think it will be more interesting and instructive to select two or three of the better-known instances and to consider them more thoroughly.

Insects may convey disease in two ways. Firstly, they may act as occasional bearers of disease-organisms, which may happen to adhere to the outside of their bodies. In this way they may become fortuitous carriers of diseases, which are by no means entirely dependent upon them for propagation, but whose spread may under favourable conditions, be greatly increased by insect agency. There is no doubt, for example, that the common housefly may be, and is, a disease carrier.

When the late Mr. Darwin was investigating the methods by which plants might be conveyed to oceanic islands, apart from human agency, it occurred to him to examine the legs of birds. He found that it was not uncommon for small particles of earth to be found adhering to their legs and feet, and that this earth sometimes contained seeds, which could germinate and produce plants.

So that birds migrating or blown from a continent and alighting on an oceanic island might carry with them the germs of plants. The case of the house-fly is analogous. Its tastes are unfortunately diverse. It appears equally fond of filth and fæcal matter on the one hand, and of food prepared for mankind on the other. That a fly alighting on any substance containing bacteria, and subsequently alighting on a suitable culture medium, will inoculate the latter with bacteria is easily understood, and has been frequently verified by experiment. The disease-organisms most likely to be conveyed by flies are those of typhoid fever, and of dysentery and other diarrhœal disorders. If a fly, which has visited material containing these organisms subsequently alights on some food material, such as milk, which is a suitable culture medium for the disease organism, this food will within a few hours, in warm weather, teem with the organism, and any susceptible person who imbibes it will probably contract the disease. Though this is not of course the only way in which typhoid and dysentery bacilli may reach food material, it is, I think, one of the commonest and most dangerous. Again, a fly alighting on an inflamed eye, will carry away with it pus organisms, which are implanted on the next eye which the fly visits, and so the fly may convey ophthalmia. This disease may, of course, be conveyed in other ways, but the fly is a most persistent and dangerous carrier.

What practical lessons may we draw from these facts in the way of prevention? The house-fly, we are informed by the entomologist, "runs through its life-history in a very short time. It lays about 150 very small eggs on dung, or any kind of soft damp filth; the larvae hatch in a day or two, and feed on the refuse; they may be full-grown in five or six days, and then pupating may in another week emerge as perfect flies." Consider what this means. Assume that $\frac{2}{3}$ of the progeny of a female fly survive. In two weeks the solitary fly has become 100, of which we will suppose half are of each sex. In four weeks they are 5,000. In six weeks 250,000. In eight weeks, 12,500,000. We need not carry our calculation any further. Evidently a plague of flies is no miracle, and any direct assault on the insect by flypapers or otherwise in a very feeble palliative.

If we want to keep down the numbers of the fly, we must keep down the food material of its larva. We must do our own sanitation, and not let the fly larvæ do it for us. This is the root of the matter. There are certain palliatives, which are, however, not to be neglected, for I am not so sanguine as to expect to see the domestic fly banished from our midst; we must expect to see some, even though in reduced numbers. It is possible to exclude flies from dwellings by fly-proof doors and windows but at the expense of diminished light and air. We should at least exclude them from our food, and more particularly keep them out of the milk-jug. A small piece of mosquito-net, weighted round the edge with glass beads is sufficient for the purpose. All fæcal matters should be well-covered from flies, and the further addition of some disinfectant whose odour is disagreeable to the fly is a precaution not to be despised. In country districts where cowdung and horsedung are abundant, and inhabitants are few, palliative measures are, I fear, all that can be adopted.

While this method of conveyance of disease-germs by flies and other insects is probably more common than is generally suspected, there is a second class of instances in which the insect plays a more important role. In these the disease-germ is conveyed, not by accidental contact with the outer surface of the insect, but in its interior, and is inoculated into the body of the affected animal by the bite of the insect. Of these many examples are now known, from which I will select a few of those which have been most thoroughly investigated in connection with the human subject.

MOSQUITOS AND FILARIA.

Considerations of time will prevent me from more than a passing reference to the propagation of filarial disease by the mosquito. It is of interest, as being the first disease in man, which was proved to be conveyed exclusively by the bite of an insect, in this instance the common House Mosquito, *Culex fatigans.* The adult worm, which was first discovered by a member of this Society, the late Dr. Joseph Bancroft, inhabits the lymph vessels of man. Its embryos are discharged in myriads and through the

lymphatics, enter the blood stream, where they may be discovered in the blood of the superficial vessels during evening or night, as minute lively motile worms, disappearing in the daytime. *Culex fatigans* is a nocturnal insect, and bites during the hours when the filariæ are near the surface. Sir Patrick Manson, many years ago, discovered that the embryo filariæ escape from the stomach of the mosquito and develop in its thoracic muscles, increasing largely in size. This discovery has been confirmed by many later observers, among whom I may name Dr. Thomas Bancroft. More recently it has been shown that the larvae, when sufficiently grown, penetrate from the thorax of the mosquito into the proboscis, and from thence enter the blood stream of the human subject during the act of biting.

MOSQUITOS AND MALARIA.

Since the earliest beginnings of medical science it has been known that the inhabitants of certain districts, and visitors to those districts, are peculiarly liable to attacks of fever, characterised by their intermittent or remittent course. To these many different names have been given, such as ague, splenic fever, intermittent or remittent fever, paludism, malaria, besides a large number of local names derived from the districts in which fevers are prevalent. Though largely confused with other fevers, they had certain peculiarities, such as a frequent tendency for the attacks to recur at daily intervals, or on alternate days, or every third day, the so-called quotidian, tertian, and quartan agues. As a rule these attacks recurred at the same hour of the day, and often ran through three stages, more or less defined, the cold, hot, and sweating stages. It was also well-known that those who had suffered from such attacks were very apt to suffer from them again, even after long intervals of time, and removal to healthy districts, where the disease was not known to occur. Again, those who had suffered much from these attacks were known to develop an enlargement of the spleen, and, when microscopical examination became a method of research, deposits of minute particles of a blackish pigment were found in the spleen and other organs after death. In the seventeenth

century it was discovered that the attacks were preventable by the administration of large doses of quinine, and that the disease could be in most cases cured by the use of this drug. This discovery was valuable, not only for its therapeutic effect, but in differentiating malarial from other fevers, which were not influenced in the same way by quinine. But it threw no light on the causation of malaria, as to which the only thing really known was that it was a *place disease*. As to what peculiar feature of the locality was responsible there were various theories. One ascribed it to something in the drinking water, and this seemed to be supported by the fact that many fever districts were marshy, and that some had been freed from fever by drainage. But the most prevalent opinion was that malaria—as its name implied—was propagated through the atmosphere, and that the air was contaminated by exhalations from the soil of certain districts. But these exhalations were mere suppositions, and the various theories were gropings in the dark without a real clue.

The first ray of light came in 1880, from M. Laveran, a French physician working in Algiers. Laveran discovered peculiar bodies inside the red-blood corpuscles of patients suffering from malarial fevers, and recognised them to be the parasites that caused the disease. This discovery was at first received with considerable scepticism. The parasites were inconspicious and hard to find. Though many diseases were known to be due to various bacteria, these parasites were protozoa, belonging to the animal kingdom, very different to bacteria, and incapable of cultivation outside the human body. Nevertheless, by the labours of many observers, the life-history of the parasites inside the human body was thoroughly worked out, and their causal relationship to the disease sufficiently established. The earliest stage of the parasite is a minute colourless protoplasmic speck inside the corpuscle. It shows active amoeboid movements, and gradually increases in size at the expense of the corpuscle, at the same time developing blackish specks of pigment in its interior. After reaching full size it begins to show signs of segmentation, and assumes the rosette form. Finally the rosette separates into a number of minute spherules or spores, the corpuscle breaks down,

and the spores are liberated. Many of them are swallowed by the phagocytes of their host, but some escape and contrive to enter fresh red cells, in which the cycle of development is renewed. It is a very significant fact that the parasites may be present abundantly in the blood during the period in which the patient is free from fever, but the febrile paroxysm follows immediately on the stage in which the spores are liberated from the broken-down corpuscles. The intervals between the paroxysms and the frequency of their recurrence depend on the life-history of the parasites. Of these, there are several varieties differing slightly in their morphology, and considerably in the symptoms of the disease, which they cause. Into these differences we need not enter; in the main points the various parasites are closely similar.

Though the discovery of these facts was a notable step in advance, we were nearly as far as ever from understanding the causation of malaria. In what way, and under what conditions do the parasites enter the human body? For the answer to these questions we are mainly indebted to two British observers, Sir Patrick Manson and Sir Ronald Ross. Manson, starting from the proposition, that every parasite has some way of getting out of the body of its host, drew special attention to a remarkable form of the parasite, which had been previously discovered by other observers, without its true significance having been recognised. This is the so-called flagellate body. It is never found in blood freshly drawn, but appears only when the blood has been exposed to examination for some time after withdrawal. In such a preparation some of the parasites may be observed to slip out of their containing corpuscles, assume a rounded form, and suddenly project a half-dozen long whip-like arms, which perform rapid lashing movements, and finally break away and swim freely in the serum.

This striking phase in the history of the malaria organism was rightly regarded by Manson as the first phase in its extra-corporeal life-cycle, and he suggested that this stage of its life was passed in the tissues of the mosquito, and that from the mosquito the parasite in some way again entered man. A young Indian army surgeon, Ronald

Ross, was so much impressed with Manson's theory that he determined to verify the transmission of the malaria parasite by the mosquito if possible. His first observations were encouraging. He found that the process of exflagelation occurred in blood taken into the stomach of a mosquito much more freely than under other conditions. But here his progress stopped. He was not able to trace any development of the separated flagella, nor could he find in the tissues of mosquitos which had bitten malarious patients, any parasites that could be identified with the malaria organism. The research was an arduous and difficult one. He could not know what the organism he was looking for would be like, that is to say what form the malaria organism would assume in the mosquito. Again he could not know what species of mosquito, if any, were concerned in the matter, and at that time very little was known of the genera and species of mosquitos.

For two years, with admirable zeal and perseverance, Ross devoted his spare time to this quest, and dissected and microscoped many hundreds of mosquitos without success. Then having by chance obtained a few specimens of a mosquito hitherto unknown to him, and having fed them on malarious blood, he found on dissection, several days later, some round pigmented cells in the stomach of the mosquito. Such cells he knew were not normally present in the stomachs of mosquitos, and at last he had found his clue. Unfortunately, at this stage, official duties prevented his carrying the research further, and the next ray of light came from an American observer, MacCullum. MacCullum observing a parasite in the blood of birds, the halteridium, which is allied to that of human malaria, found that after exflagellation, the separate flagellæ swam about until they encountered and fused with certain rounded forms of the parasite, and that these thereupon assumed a vermicular form and exhibited active movements. That in fact the process was one of sexual conjugation, followed by a fresh stage of development.

At this stage, the Indian Government took a very enlightened step. They relieved Ross of his military duties, and sent him to a well-equipped laboratory in Calcutta to investigate the mosquito-malaria theory. It happened

to be the wrong season of the year for malaria, but nothing daunted, Ross commenced to investigate a closely allied organism, the *proteosoma*, found in sparrows. He had no difficulty in proving that round pigmented cells appeared in the stomachs of mosquitos that had fed on infected birds, just as he had formerly observed in malaria. He followed the development of the parasitic cells and found they gave rise, by internal sporulation to a number of fine rod-like spores which escaped into the tissues of the insect. And now came his crowning discovery. Dissecting an infected mosquito, he came upon two small glands connected by a duct with the proboscis. To his astonishment, he found the cells of these glands packed with enormous numbers of these parasitic rods. The inference that these rods were intended to pass with the secretion of the salivary or poison gland into the next bird bitten by the mosquito was obvious. He subjected it to the test of experiment, and found that birds whose blood was free of proteosoma, could be certainly infected by the bite of such mosquitos. That the malaria organism had a similar life-history appeared almost certain, and an Italian observer, Grassi, soon after confirmed Ross's conclusions with regard to this parasite.

The study of mosquitos was until recent years a much neglected province of entomology. But since Ross's discovery, so much attention has been given to the subject, that they are now among the most completely known families of insects. We now understand the reason of Ross's early failures in his investigation. Mosquitos may be divided into two groups—the *Culex* group, which comprises the great majority of forms, both in individuals and species, and the *Anopheles* group, which are far less noticeable by the casual observer, and yet are exclusively concerned in the propagation of malaria. Without entering into technical details, it is easy to enable anyone to recognise the difference between members of these two groups, both in the larval and mature stages. Mosquitos of the *Culex* group have the larval form which is so familiar to us in our domestic water. These little wrigglers are, of course, air breathers, and ascend to the surface of the water to breathe through a conical projection, called the

siphon, situated towards the tail, while the head hangs nearly vertically downwards. *Anopheles* larvae have no projecting siphon, and rest nearly horizontally on the surface while breathing. The mature *Culex*, when it alights, rests with the body horizontal, and the head well elevated. *Anopheles* rests with the body steeply inclined, and the head depressed, as though the proboscis was pinned into the surface rested on. The species are more quiet and retired in their habits than those of the *Culex* group, and need to be searched for, while the latter make their presence evident, whether we wish it or no.

We are now able, thanks to the work of later observers, to give the complete life-cycles of the malaria organism both in man and the mosquito. First we have the asexual circle as already described, occurring in the blood of the human host. It is now known that sexual forms also occur in human blood. They are most easily distinguished in the pernicious variety of malaria, where they are sausage-shaped, distorting the containing corpuscle to form the familiar "crescent bodies." The male and female forms can be distinguished by slight differences in the size and staining of the nuclei and cell granules. Confined to the human body, the male forms undergo no further development and die out. The female forms are more resistant, and indeed are capable of surviving when all the remaining forms of the parasite are killed off by quinine, or by the natural resistance of the host. When, however, this resistance is lowered by some external cause, such as a chill, they undergo a parthenogenetic development. The nucleus divides into two parts, the darkly staining portion divides into spores as in the asexual cycle, the paler portion which represents the sexual element is abandoned as useless to the organism. Meanwhile the unfortunate host experiences a relapse of his ague.

But when the blood is imbibed by a mosquito, the course of development is altogether different. The digestive juices of the insect destroy all but the mature sexual stages of the parasite. The crescents slip out of their corpuscles, and assume a rounded form, and undergo development. The nucleus of the male is transformed into the threads commonly known as flagella, but more accurately termed

microgametes. These, four to six in number, are rapidly shot out from the surface. They contain the nuclear chromatin, that is the portion concerned in reproduction, and lash wildly about, finally breaking away and swimming in a serpentine fashion, until they find and conjugate by fusion with one of the female cells. The fertilised cell develops into a rather elongate motile worm-like individual, which pushes its way through the epithelial lining of the mosquito's stomach. There it becomes a spherical, motionless rapidly-growing cell in a cyst-like envelope. The nucleus divides as it increases in size, and each daughter-nucleus again divides until the cell becomes filled with a crowd of spores, from some hundreds to over ten thousand, which are set free by the bursting of the cyst. The spores are minute spindle-shaped actively motile bodies. They are carried in the body-fluid of the mosquito until they reach its salivary or poison glands, which are filled with them. When the mosquito next takes a feed they pass down its proboscis into the blood-vessels of the man bitten. In his circulation, they develop according to the sexual cycle from which we started.

Now that this really marvellous life-history has been fully elucidated, there can be no doubt in the mind of any biologist that malaria is propagated by the mosquito; and we have no evidence that it can be propagated in any other way. This conclusion has been confirmed by rigorous experiment. Mosquito-proof huts have been erected in the most malarious parts of the Roman Campagna, and observers living in them throughout the fever season, have remained free from malaria. On the other hand, mosquitos which have been allowed to bite a malarious patient in Rome have been sent by post to London, and have there successfully infected an Englishman, who had never visited a malarious district. Already the knowledge acquired has borne practical fruit. We may free a district from malaria (1) by treating *all* the inhabitants of a district, including especially all the children, by quinine in sufficient doses to exterminate the malaria parasites in their human cycle. This method has been pursued with some success by Professor Koch, but the difficulties in pursuing it with thoroughness are immense, and unless thorough it is useless.

(2) By isolation of all infected by mosquito netting. This is impracticable. To some extent the healthy may be protected by netting, but the isolation from mosquitos is difficult to sustain. (3) By exterminating the Anopheles in its larval stage (*a*) by drainage (*b*) by screening all domestic water, and (*c*) by periodical spraying of all exposed feeding places with some form of petroleum. In this way various places have already been freed from malaria, if not entirely at least for the greater part. No doubt the task before the sanitarian is immense, but malaria is no longer inevitable. If we continue to suffer, it will not be for lack of scientific knowledge, but because of the ignorance, indifference and indolence of mankind.

MOSQUITOS AND YELLOW FEVER.

As Yellow Fever is fortunately unknown in this part of the world, it is necessary to give you some idea of what the disease is. This can be best done by comparing it to a disease with which most of us are familiar—Dengue. Like that disease, it has a sudden onset with fever, shivering, headache, pains in back and limbs, nausea, vomiting, and other symptoms. This stage lasts from a few hours to a few days, and is followed by a remission, known as the stage of calm, in which the symptoms subside. In favourable cases, this is succeeded by convalescence, but in others the temperature again rises, jaundice develops rapidly, and in bad cases altered blood is ejected from the stomach—the "black vomit"—bleeding occurs into the skin or other organs, or from the kidneys, and the patient dies. Like Dengue, it attacks a large proportion of the population, but unlike that disease it is fatal in a large proportion of cases, from 15 to 85 per cent. The towns of the Southern United States have been frequently the seat of epidemics. In New Orleans, in 1853, there were 29,020 cases, with 8101 deaths. In 1793, the town of Philadelphia contained 40,144 inhabitants, of whom 4,041 died of yellow fever—just one-tenth. I will not harrow you with details of these epidemics, I mention these facts merely that you may realise the importance of the question, that for over a century puzzled the medical profession of the United States, the question as to how yellow fever was spread. At first it

was held by the great majority to be a contagious disease, communicated directly from the sick to the healthy. This was of course the belief of the general public, and a general dread of infection and fear of approaching the sick added much to the horrors of the epidemics. But many facts appeared to controvert this theory of direct contagion, and gradually the opinion that yellow fever was a non-contagious and non-communicable disease became prevalent among the profession. This theory, however, failed to explain all the facts, and after much controversy, a middle position became generally held—that while not directly communicable from the sick to the healthy, yellow fever was spread by emanations from the sick which required a suitable nidus in which to germinate and develop before they attacked the healthy, and that this nidus was furnished by clothing, furniture and various articles of merchandise to which collectively was applied the term *fomites*.

This was the received theory in the year 1900. Many investigations had been made to discover the causal organism of the disease, but none had succeeded, though several observers had isolated organisms which were at first supposed to be those sought for. Meanwhile, the disinfection of fomites was the official weapon with which epidemics were combated. Dense ignorance prevailed as to the real mode of spread of the disease, and on this ignorance was based an official routine which was of small value for the purpose for which it was intended.

In this year, 1900, yellow fever appeared among the American troups in the island of Cuba, and a commission of medical officers of the United States Army was appointed to investigate the etiology of the disease. The head of this commission was the late Walter Reed, a U.S. Army surgeon, and to him we owe our present knowledge of the propagation of yellow fever. He was to some extent anticipated. Dr. Carlos Finlay, a physician of Havana, had promulgated the theory that yellow fever was spread by mosquitos, without, however, producing any cogent evidence in its favour, and he had few if any adherents. Nevertheless, some observations made by Reed on an epidemic in some barracks near Havana disposed him to believe that Finlay's theory had much to commend it, and was at least worth

investigating. The true nature of this outbreak had not been recognised until 35 cases had occurred, with 11 deaths. No precautions had therefore been taken with regard to the disinfection of bedding and clothing; but the disease had not been contracted by the nurses nor by the men who washed the clothes. Indeed a little inquiry showed the presence of contaminated clothing in all of the eight barrack-rooms without apparent detriment to the occupants. This threw grave doubt on the accepted theory of propagation by infected *fomites*. Yet at the same time, a prisoner who had been in strict confinement in a cell of the guardroom for seven weeks contracted the yellow fever. Eight other prisoners in the same room escaped infection, though one of them continued to occupy the bunk vacated by the sick man. It was exceedingly difficult to explain this isolated case, but it was conjectured that some insect capable of conveying infection, perhaps a mosquito, had entered through the cell window, and bitten this particular prisoner. This was of course, merely a supposition, but it was not apparently possible to explain the case in any other way.

It seemed therefore advisable to Dr. Reed that the scheme of work planned out by the commission should be altered, so that its chief endeavour should be turned to the proving, or disproving the agency of the mosquito as an intermediate host in the spread of yellow fever. Fortunately, the mosquito selected for experiment, the *Stegomyia fasciata*, proved to be the right one. As the experiments proposed involved grave danger to life, it was considered that the members of the commission should run the risk themselves, before subjecting anyone else to it. The first successful experiment was performed on Dr. Carroll. The insect, which had been hatched and reared in the laboratory had been caused to feed on four cases of yellow fever, twelve, six, four and two days previously. Carroll duly contracted a severe attack of the disease from which his life was in the balance for several days, but eventually he recovered. Another member of the commission, Dr. Lazear, subsequently succumbed to a fatal attack after being bitten by a mosquito in the fever ward, but in his case the infection was an accidental one, and not having

been made under rigorous scientific conditions, it could not be proved that the mosquito had actually conveyed the disease. Eleven other experiments similar to that on Carroll were made; of these nine were negative, two positive. The negative experiments might be explained in several ways. The cases of yellow fever through which the mosquitos were infected were very mild, and the infection might not have been sufficiently virulent; or the interval between the two bites might not have been the right one. The positive experiments could not be explained away. A *prima facie* case for the mosquito as the intermediate host for yellow fever had been made out.

It remained now to subject the mosquito theory to a fresh trial on a larger scale and under rigorous conditions. Forunately for the commission, the then military Governor of Cuba, Major-General Leonard Wood, was an officer formerly in the medical service, and his scientific training enabled him to comprehend the nature of the experiments proposed, and to appreciate their importance. It is the common fate of scientific investigators to be misunderstood, and to find their work starved by the false economy, or thwarted by the interference of high government officials. In this instance, however, every assistance required was liberally furnished. An isolated camp was established, volunteers from the U.S. Army were called for, and offered themselves freely, though fully informed of the risks that they would run. One cannot refrain from noting the very high courage shown by those who thus voluntarily risked their lives in a campaign more calculated to inspire fear than many military operations. Those in the camp were subjected to strict quarantine, so that the possibility of accidental introduction of infection might be excluded. The pulse and temperature were taken thrice daily, so that any that might be incubating the disease should be at once detected, and this was continued until they had passed the full period of incubation of yellow fever, without developing any symptoms. Two buildings were erected in the camp, of similar size and construction, except that one known as the "Infected Mosquito Building," was divided in the middle by a permanent wire screen partition, and was well ventilated. The other known as the "Infected

Clothing Building" was purposely so built as to exclude efficient ventilation. Both were provided with wire screen windows, and double wire screen doors, so that mosquitos could be kept within or without the buildings, as the experimenters might desire.

The results of the experiments may be very briefly summarised. Non-immune subjects exposed to the bites of mosquitos that had previously bitten yellow fever patients were readily infected, provided the interval between the bites were at least twelve days. Before that interval the mosquitos were harmless, but they maintained their virulence for as long as eight weeks. Control subjects separated from the mosquitos in the same room by a wire partition remained uninfected. Meanwhile, in the "Infected Clothing Building," non-immune subjects lived and slept among clothing soiled by the discharges of yellow fever patients, and even wore the very shirts in which these patients had been clothed, for so long as twenty days without a single instance of infection. This experiment disproved the virulence of "fomites" in yellow fever. The problem of the method of transmission of yellow fever had been solved in the most conclusive way.

The practical importance of this discovery is immense. Yellow fever epidemics can now be stamped out. The method is simple. As soon as a case of the disease is notified, the patient is promptly isolated by wire screens, so as to prevent the possibility of mosquitos becoming infected from him. At the same time, the whole house is fumigated so as to destroy any mosquitos that may have already become infected. In addition, a "mosquito brigade" is organised to destroy the larvae of *Stegomyia fasciata* in their breeding places throughout the town. This mosquito is, I may observe, very abundant in Brisbane. We breed it in our water tanks, and if ever a case of yellow fever is imported here, which in these days of rapid travelling is not impossible, every condition is present to favour the occurrence of a considerable epidemic. We may then realise more fully the value of Dr. Reed's experimental work.

All the evidence at our disposal fails to indicate that yellow fever is spread naturally in any other way than

that I have described. But it may be communicated artificially by the direct inoculation of the blood of a patient suffering from the disease. Nevertheless, the most refined microscopical and cultural methods have not been successful in revealing in this blood the living organism that causes the fever. The germ of yellow fever still remains undiscovered. There is indeed good evidence that it is ultra-microscopic, for, unlike the smallest living organisms discovered by the microscope, it passes through the pores of a Berkefeld filter. The discovery of its method of propagation depends entirely on experiment, and is indeed one of the best instances of the application of the experimental method in medicine. As such, it is one of the greatest triumphs achieved in modern times in the prevention of one of the most deadly epidemics known to afflict mankind.

RATS, FLEAS, AND PLAGUE.

Early in 1900, Australia was invaded by the plague. Human nature is so constituted as to tolerate with indifference and apathy those epidemic diseases which are familiar, but to fly into a panic at the mere report of those which are novel. In the present instance, panic was doubly inevitable, for the plague had been practically unknown for centuries among European peoples, and the very name was charged with the vague terrors of old epidemics ; and particularly with recollections of the great plague of London in the seventeenth century, described by De Foe, an author distinguished for his talent in writing fiction so realistic in style, as to be indistinguishable from the facts, which are no doubt imbedded in his narrative.

At this juncture, I was appointed a special medical officer by the Government to advise and report regarding the epidemic in Northern and Central Queensland, some cases of plague having been reported in Rockhampton and Townsville. My first duty was to visit Sydney, where plague had been rife for several months, to acquire information. The situation, as I found it in that city, was certainly remarkable. On the one hand were a populace and a Government treating plague as a virulently infectious disease to be stamped out at any cost, regardless of expense,

private interests, and public convenience. In pursuance of this policy, every occurrence of plague was notified to the police, and not only the patient, but every one on the premises, and in the case of an hotel, their number might be considerable, was conveyed to the Quarantine Station, on the other side of the harbour. These proceedings certainly made a great stir, and had an appearance of energy. But I found to my surprise that the highest authorities in the Department of Health held views as to the epidemiology of plague, which were, to put it mildly, hardly consistent with these administrative measures. To them the infectiousness of plague from patient to patient was very problematical, and played very little if any, part in spreading the epidemic. They regarded plague rather as a disease of the rat, occasionally communicated to mankind, probably by the bite of rat-fleas, and therefore requiring for its prophylaxis entirely different measures from those that I have described. While excellently devised to stamp out an epidemic of small-pox, isolation and segregation of contacts were, they considered, quite inoperative in the case of plague, except in so far as they facilitated the cleansing of affected dwellings and areas and the destruction of rats.

To understand how this position was arrived at, we must briefly recapitulate the position at that time of scientific knowledge regarding plague. The discovery of the bacillus of plague was made in Hongkong in 1894 by Kitasato and Yersin, and since then there has been no room for doubt that the *bacillus pestis* is the causal organism. But its method of spread from case to case long remained a matter for conjecture. One of the characteristics of the plague organism in artificial culture is its slight power of resistance to unfavourable conditions. It behaves in the laboratory rather like a frail exotic, and in mixed cultures is readily killed out by more vigorous saprophytes. It does not survive long when dried in the ordinary way, and the conjectures that plague may be due to food or soil contamination had never any solid foundation. Again on the assumption that the disease is infectious it is difficult to understand how the bacilli make their exit from the patient. Certainly, in the rare cases of pulmonary plague, the bacilli are con-

tained abundantly in the sputum, and these cases are extremely infectious, as was shown in the small outbreak in Maryborough, in 1905. But in bubonic plague, and even in the septicaemic form, there does not appear to be more than an occasional and trivial exit of the bacillus, and in these cases, which form the vast majority, plague has been found by experience to be non-infectious.

It has been known for a long time that true plague is not a disease limited to the human species. Not only can many, we might say most or all mammalia, be infected by artificial inoculation, but the disease has in many species occurred under natural conditions. Especially is this the case with rodents, and among them the species of *Mus* that are associated with mankind are affected above all others. It has been found in Australia that epizootics of rat-plague have accompanied and preceded outbreaks of human plague, and this has been so also in many other parts of the world. It has been the case so uniformly, wherever adequate research has been made, as to suggest a causal connection between the epizootic and the epidemic. That is to say that plague is primarily a disease of the rat, communicated from rat to rat, and incidentally communicated, when the conditions are favourable, from rat to man. Now it is obvious that the conditions under which plague spreads naturally from rat to rat are open to experimental investigation, and if these were satisfactorily established, much light might be expected to be thrown on the occurrence of the disease among mankind.

The first direct experimental evidence as to the natural method of rat infection was obtained in Bombay, in 1898, by Simond, who showed that plague could be conveyed from one rat to another, not allowed to come into contact with it, provided fleas were allowed to pass from the infected to the healthy rat. He observed that on rats suffering from natural plague fleas were usually abundant, and that the fleas that left a rat which had died of plague contained virulent plague bacilli. Plague in man, he attributed to the infected persons having been bitten by fleas which had left a plague rat. This conclusion was strongly supported by an epidemiological study of the epidemic in Bombay, by Hankin, published in the same year. This rat-flea

theory of plague formed the working hypothesis adopted in Sydney in 1900 by Ashburton Thompson and Tidswell, and considerably strengthened by their observations.

In other parts of the world, however, this theory was received with less favour. Some observers flatly denied that rat-fleas would bite human beings. An Indian Plague Commission came to the conclusion "that Simond's proposition that suctorial insects play an important part in the transmission of plague from sick to healthy animals is so weak as to be hardly deserving of discussion." The more recent investigations of Gauthier and Rayband in Marseilles, of Liston in India, and especially of an Indian Plague Commission at present working in Bombay, whose preliminary reports were published in 1906 and 1907 have placed the rat-flea theory in an absolutely incontestable position as the natural method of plague infection. Let me briefly summarise the present state of our knowledge.

The species of *Mus* concerned are three :—

(1) *Mus rattus*, the Black or Old English Rat now almost exterminated in Great Britain by the Brown rat, but still abundant in countries in which plague has become endemic. This rat is a nimble climber, and lives in houses, preferring the space under the roof. It is also the common rat on ships. It has a reddish variety, known as the Alexandrine Rat—*Mus alexandrinus rufus*.

(2) *Mus decumanus*, the Grey, Brown, or Norway rat, which is a heavier, but clumsier animal, and lives especially in sewers and drains, from which it invades the basements and cellars of houses.

(3) *Mus musculus*, the Mouse. Of these, the last appears least susceptible to plague, and the number found to be infected is comparatively small. The two former are both extensively infected during the epizootic, but as Dr. Ham shows in his recent admirable report on the Plague in Queensland, *Mus rattus* and its variety *alexandrinus* is most concerned in the spread of plague in man, owing to its predeliction for human habitations.

So much for the rats. Special attention has been devoted of late to the study of rat-fleas, and the flea which has been proved to be the carrier of plague has been discovered to be a species almost unknown in temperate

Europe, but common in warm climates, which was till recently undescribed, but is now known as *Pulex cheopis*, Rothschild. Several species of flea are found on rats. The human flea, *Pulex irritans*, and the dog-flea, *Pulex serraticeps*, are occasionally found, but merely as stragglers. There are three species specially attached to the rat, known as *Ceratophyllus fasciatus*, *Ctenopsyllus musculi*, and *Pulex cheopis*. Much experimental work has been vitiated by neglecting to identify the species of flea concerned.

Pulex cheopis is nearly allied to the human flea. That it will readily bite man has been ascertained repeatedly. The statement that rat-fleas will not bite man are derived from experiments with the other species. It can indeed be kept alive for weeks by being allowed to suck human blood. Furthermore, it has been found on man. For instance, Liston writes, "About the 6th or 7th of April, rats began to die in large numbers in a chawl, or block of tenement houses. Suddenly the deaths among rats ceased, and on April 11th, the people became troubled with fleas. The fleas became so numerous that they had to quit their rooms and sleep out on the verandah. While living on the verandah on April 17th, one of the inhabitants of the particular room in which the fleas were taken became infected with plague. Another case occurred on the same day in a room adjoining. The people who inhabited the room where the above case occurred, were induced to collect some of the fleas. An examination of this collection was most instructive. Now I must tell you that on previous occasions, of 246 fleas that were caught on man under normal conditions, I had found only one rat flea, *Pulex cheopis*. But of the collection of 30 fleas caught on man under the circumstances above recorded, no less than 14 were rat fleas."

Though the geographical distribution of the rat-flea has not yet been worked out, there are indications that the freedom of certain ports from plague infection are due, not to any unusual vigilance in their port authorities, nor to any superior excellence in their sanitary conditions. but merely to the scarcity or absence of this particular flea on the local rats.

Let me now give a summary of the experimental

evidence from which we know that plague is propagated by *Pulex cheopis* :—

(1) Two wire cages are placed in a glass box. The cages rise above the level of the box, and both box and upper portion of cases are covered with fine muslin impervious to fleas. In case A. is placed a rat inoculated with plague, together with 10 to 20 living *Pulex cheopis*. As soon as the rat is dead, a healthy rat is placed in cage B. There is no direct contact between this and the first rat, nor with its excretions. The rat in cage B. develops plague. Some of the fleas are to be found on rat B. on examination. This experiment has been repeated many times.

(2) A rat is inoculated with plague. After death, it is searched for fleas. These are caught and transferred to a flea-proof cage containing a healthy rat. The latter dies of plague. On it are found some of the fleas, and in the fleas are plague bacilli. This experiment has been repeated many times.

(4) Simond, Gauthier and Rayband, and Liston never succeeded in infecting animals from one another when healthy and plague-infected animals were confined together in the same cage if fleas were excluded, and if the animals were not allowed to devour the bodies of their dead comrades. The recent Indian Commission verified this on a large scale. Fifty healthy guinea-pigs were confined with ten inoculated with a plague culture under flea-proof conditions. The latter all developed plague, but none of the former. The same experiment was repeated. One of the uninoculated animals developed plague. The animals were examined, and one rat-flea was found. The other forty-nine uninoculated escaped. Forty-nine guinea-pigs were confined, with ten inoculated guinea-pigs, rat-fleas being known to be present. In seventeen days, every guinea-pig was dead of acute plague. From the last two animals four-hundred fleas were recovered. And so on with similar experiments. For instance, guinea-pigs placed in a cage in a compartment where a guinea-pig plague epizootic was in progress, frequently contracted plague if the cage was suspended two inches from the floor, and fleas were found on them; but if suspended two feet from the floor, remained free from both plague and fleas. The rat-flea cannot jump two-feet

high. A similar experiment was performed with two monkeys placed in cages of similar pattern, one unprotected, the other surrounded by a layer of "tanglefoot," six-inches wide. After two nights they were removed. Two fleas were caught on the unprotected monkey, while five fleas were found stuck on the "tanglefoot." The first monkey developed bubonic plague, the other remained healthy.

(5) Guinea-pigs were let loose in houses in which cases of plague had occurred recently. Large numbers of *Pulex cheopis* were subsequently collected from these guinea-pigs, and they died of plague. If, however, the guinea-pigs were in cages protected by flea-proof gauze, they escaped plague. In similar cages not protected with gauze ten per cent. of the guinea-pigs contracted plague, and fleas were found on them, though in fewer numbers than on the guinea-pigs that were allowed to run about.

This evidence is conclusive. For further details, I must refer to the original report. But one point must be mentioned. Rats can be infected by feeding on plague-contaminated material, for instance, the bodies of their dead comrades. In these cases, there are well-marked pathological lesions in the intestines and mesenteric buboes. In naturally infected rats, intestinal lesions and mesenteric buboes were not found in 5,000 infected animals examined. The Commission conclude that transmission by feeding is not of common occurrence in nature, and is not the method by which the epizootic is propagated.

We find then that plague epizootics among rats are propagated by a particular flea, *Pulex cheopis*. This flea leaves the rat soon after death, with its stomach engorged with blood, swarming with plague bacilli. In default of its natural host, it will fasten on other animals, and biting them will infect them with plague. This is not true only of other rodents like the guinea-pig, but of an animal widely remote from the rat and akin to man, the monkey. *Pulex cheopis* will bite man freely. The inference that plague may be and is conveyed to man from the rat by this particular flea is inevitable. With the exception of plague pneumonia, there is no reason for supposing that plague is naturally acquired in any other way. How well this

conclusion agrees with the epidemiology of plague as observed in Australia, may be learnt from the able reports issued by Dr. Ashburton Thompson and Dr. Ham.

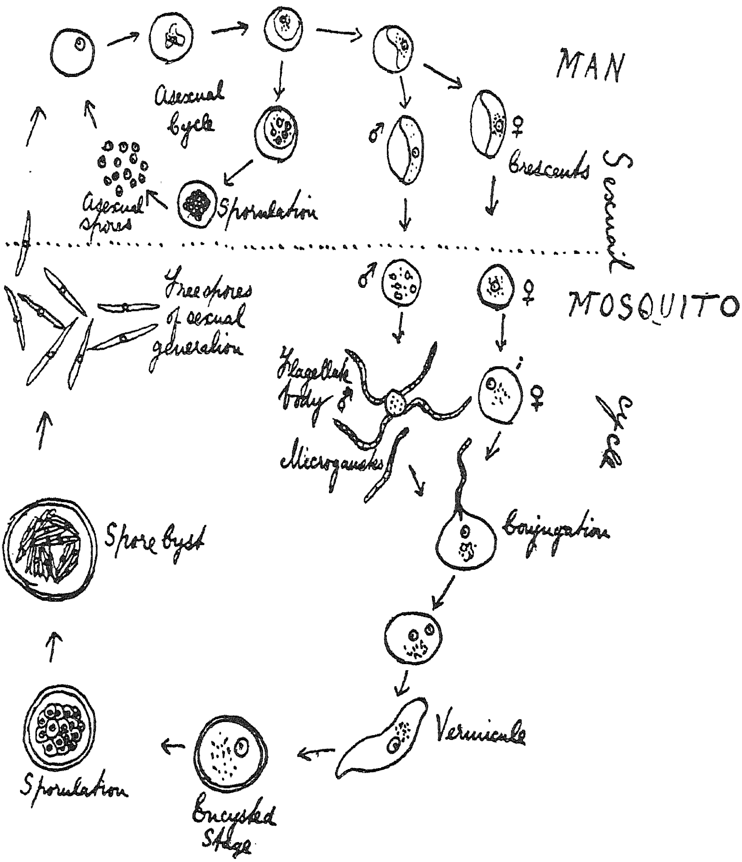
I have sufficiently transgressed on your patience, but did time permit I might give you details of yet other diseases of mankind spread by insects, for instance, the sleeping sickness, which is spread by a species of tsetse fly, and the spirillar fever of West Africa, which is spread by the bites of a species of tick. If diseases of domestic animals were included, we might study the tsetse-fly disease of cattle and horses in Africa, or the tick-fever of cattle, which is so unfortunately familiar in our own country. But this would be too large an undertaking for the present occasion.

It is probable that the list of human diseases spread by insects will be extended in the future. Among diseases which are probably so spread, I may mention Dengue and Leprosy. The organism of Dengue is unknown; the reasons for connecting it with mosquitos are (1) its similarity to yellow fever, and (2) certain peculiarities in the spread of epidemic, which suggest that, in the beginning of an epidemic at all events, it is a *house disease*. The hypothesis that leprosy is spread by insect bites is a very old one. The leprosy bacillus has been long known, and can be easily demonstrated. But it cannot be cultivated outside the body, and unfortunately, it cannot be made to grow in any animal but man. The long period of latency renders it peculiarly difficult to trace the source of infection, and as the experimental method can hardly be applied, no speedy increase in our knowledge is to be expected. With regard to Dengue, the application of the experimental method used by Reed in yellow fever is much to be desired.* If the propagation by the mosquito were proved, we might stamp out such an epidemic as vexed us in 1904. Few things have struck me more this summer than the disgraceful number of mosquitos in the houses I visit in Brisbane. I say disgraceful, because by adequate screening of domestic water tanks (which is easy, but seldom done), or by the

* Since writing this I learn that this has actually been carried out by American observers in the Phillipines, and the connection between dengue and a mosquito is now proved.

addition of a spoonful or two of kerosene to the surface of the water every two or three weeks (which has no effect on its potability), the mosquito nuisance might be readily prevented.

INTRA-CORCORPUSCULAR PARASITES.



Asexual and Sexual Cycles of the Malaria organism in Man and the Mosquito.

[AFTER MINCHIN].

Forms above dotted line occur in Man (Asexual Cycle and commencement of Sexual Cycle).

Those below in Mosquito (Sexual Cycle).

Annual Meeting of Members.

The Annual Meeting was held at the Technical College, Ann Street, on Monday, January 27th, 1908. The President, Dr. A. Jefferis Turner, occupied the chair.

Minutes of last Annual Meeting were read and confirmed.

The Report of Council and Financial Statement for 1907 were read and adopted.

To the Members of the Royal Society of Queensland.

The Council of the Royal Society of Queensland have pleasure in presenting the Annual Report for the year ending 31st December, 1907.

Twelve new members were elected during the year, and thirteen resigned, left, or were struck off the roll, leaving the membership at 114.

The following names are those of the new members elected since last Report for 1906 :—

Mrs. Hogarth, Miss L. A. Bundock, Mrs. J. B. Henderson, Major J. R. Sankey, Messrs. G. C. Willcocks, F. Pickering, C. W. Holland, J. S. Badger, F. Lord, H. M. Challinor, W. V. Ralston, and F. Smith.

Eight ordinary meetings were held during the year, when the following papers were read :—

February 23rd.—"On the Ways of a Hornet," *W. J. Young.*

"The Lepidoptera," *Dr. A. Jefferis Turner.*

March 23rd.—"The Magpie," *Robert Hall.*

"New Genera and Species of Fishes," *J. D. Ogilby.*

April 27th.—"The Geology of the Glasshouse Mountains," *J. Shirley.*

"The Keeping Properties of Microscopic Preparations stained with Aniline Dyes," *C. J. Pound.*

May 25th.—"Graphical and Mechanical Aids to Calculations," *J. C. Brunnich.*

June 27th.—"An Efficient Automatic Sand Filter," *H. Wasteneys.*

"A New Test for Mercury," *P. W. Jones.*

"The Detection of Mercury in Explosives," *J. B. Henderson.*

July 29th.—"The Forest Trees of Queensland," *Dr. Alfred Sutton.*

October 3rd.—"Coral Reefs and their Denizens," illustrated by natural colour photography, *W. Saville Kent.*

December 14th.—"The Building of Australia," dealing with the Origin of our Climate, Fauna, Flora, and Water Supply. *Professor S. B. J. Skertchly.*

"New Genera and Species of Queensland Fishes," *J. D. Ogilby.*

Interim meetings were also held of a popular instructional character.

Mr. H. M. Challinor was appointed Hon. Secretary on 25th May, in succession to Mr. F. E. Connah, who resigned that office.

Council meetings were held during the year, ten in number, and the attendance of Councillors was as follows: Dr. Turner, 5; J. C. Brunnich, 7; Hon. A. Norton, 9; Frank Smith, 6; J. Shirley, 4; J. F. Bailey, 8; W. J. Byram, 7; F. E. Connah, 10; J. B. Henderson, 8; H. M. Challinor, 7.

Proceedings of the Society, Vol. XX for 1906, together with index to Vol. XIX., were issued to members and kindred exchanging societies.

The state of the library is still far from satisfactory, but a sub-committee is now at work with the view of placing the valuable works and exchanges in better order, and of having them properly catalogued and checked on receipt. An effort to complete the work of binding the loose volumes should be undertaken without delay.

The Government endowment, which was of great assistance to library expenditure, has not been renewed,

but the Chief Secretary's Department has been approached by letter in accordance with a former promise of support made (to a deputation) in the form of free accommodation and also free binding of the books by the Government Printer. This important matter is still in hand, and should be brought to a successful issue at an early date. When this scheme is carried out, it is proposed to make the library available, under proper supervision, to the public.

A number of members are in arrears for subscriptions for 1907, but the financial statement shews a fair credit balance, and monetary affairs of the Society are on a sound basis for the new year's business. There are no outstanding accounts.

The Balance Sheet is hereto annexed.

The balance of outstanding subscriptions in June was a large one, but since then the bulk of it has been collected, and the balance still remaining will, it is expected, be obtained during the current year.

Towards the Queensland University Equipment Fund members of the Royal Society have contributed either directly through the Society, or through other channels, a sum amounting to £558 6s., together with a promise in one instance for further financial support and the endowment of a scholarship. Considering the limited membership of the Society, and the contributions from other sources (the whole total is barely £2,500 announced so far), this will indicate that the members have the vital educational interests of the State well in view, and fully recognise the great desirableness of providing the best possible system of higher education within the reach of young Queenslanders.

The Society was admitted and welcomed to fellowship with the British Science Guild during the year.

Signed on behalf of the Council,—

A. JEFFERIS TURNER,

President.

H. M. CHALLINOR,

Hon. Secretary.

Brisbane, 27th January, 1908.

THE ROYAL SOCIETY OF QUEENSLAND.

FINANCIAL STATEMENT for Year Ending 31st December, 1907.

Dr.

Receipts.	£	s.	d.
To Balance from last report	22	5	11
,, Subscriptions	82	19	0
	£105	4	11

Cr.

Disbursements.	£	s.	d.
By Rent of Rooms .. .. :	12	0	0
,, Printing Proceedings, Stationery, etc.	34	6	0
,, International Catalogue	21	7	10
,, Postage and Petty Cash	9	11	7½
,, Library Expenses	5	0	0
,, Advertising	4	4	6
,, Engraving for Proceedings	1	16	2
,, Insurance on Library	1	2	6
,, Subscription Fellowship British Science Guild ..	1	1	0
,, Typing	0	19	8
,, Bank Charges	0	10	0
,, Lighting Technical College	0	7	0
,, Commission to Collector	0	2	0
,, Balance to Credit	12	16	7½
	£105	4	11

	£	s.	d.
Per Bank Pass Book	22	18	11
Less Outstanding Cheque ..	10	2	3½
	£12	16	7½

Examined and found correct.
GEO. WATKINS, *Hon. Auditor.*
Brisbane, 13th January, 1908.

A. NORTON, *Hon. Treasurer.*

Dr. A. Jefferis Turner then read his presidential address, entitled "Insects and Diseases" (published *in extenso* in this volume), and was accorded a hearty vote of thanks by the meeting.

The following office-bearers for 1908 were then elected: *President,* J. C. Brunnich, F.I.C.; *Vice-President,* J. F. Bailey; *Hon. Secretary,* H. M. Challinor; *Hon. Treasurer,* Hon. A. Norton, M.L.C.; *Hon. Librarian,* Frank Smith, B. Sc.; *Members of Council,* Colonel John Thomson, M.B., P.M.O., Dr. Alfred Sutton, W. J. Byram, J. Brownlie Henderson, F.I.C., J. Shirley, B. Sc.; *Hon. Auditor,* Geo. Watkins; *Hon. Lanternist,* A. G. Jackson.

A vote of thanks to the retiring officers was carried by acclamation.

LIST OF MEMBERS.

Archer, R. S.
Badger, J. S.
Bailey, J. F. (Life)
Bailey, F. M.
Bennett, F.
Bernays, L. A., C.M.G.
Bright, C. E.
Brunnich, J. C., F.I.C.
Bundock, C. W.
Bundock, Miss Alice
Byram, W. J.
Cameron, W. E.
College, W. R.
Cory, A. H., M.R.C.V.S.L.
Carter, Hon. A. J., M.L.C.
Collins, Wm.
Costin, C. W.
Cooper, Sir Pope A., C.J.
Collins, Miss Jane
Chapman, R. M.
Collins, J. C.
Collins, R. M.
Connah, Frank E.
Challinor, H. M.
Cameron, J., M.L.A. (Life)
Dunstan, Benjamin
Evans, W.
Field, W.
Fox, Geo., M.L.A.
Forrest, Hon. E. B., M.L.A.
Forrest, John
Gailey, R. (Life)
Griffith, Sir S. W. (Life)
Gross, C.
Greenfield, A. P.
Gregory, W. C.
Gore, Gerard R.
Gibson, Hon. A., M.L.C.
Gray, Hon. G. W., M.L.C.
Ganly, Rev. E. C.
Henderson, J. B., F I.C.
Hedley, C.
Hirschfeld, Dr.
Hockings, P. F.
Hopkins, Dr.
Hood, W. W.
Hogarth, Mrs.
Henderson, Mrs. J. B.
Holland, C. W.
Illidge, T.
Irving, J., M.R.C.V.S.L.
Illidge, Rowland
Jack, Dr. R. L.
Jackson, A. G.
Jones, P. W.
Jones, A. Raymond
Kent, W. Saville (Life)
Lindsay, W.
Love, Dr. W.
Lord, Frederick
Lucas, Dr.
Leahy, P. J., M.L.A.
Leahy, John, M.L.A.
Marks, Hon. Dr.
McCall, T.
MacKie, R. Cliffe
May, Dr.
Miles, Hon. E. D., M.L.C.
Millar, T. W.
Murray Prior, Mrs.
McConnel, Eric W.
McConnel, James H.
McConnel, Edward J.
Marks, E. O.
Nelson, W. M.
Norton, Hon. Albert (Life)
Pound, C. J.
Pritchard, C.
Plant, Lieut.-Col. C. F.
Parker, W. R., L.D.S.
Plant, Hon. E. H. T., M.L.C.
Power, Hon. F. I., M.L.C.
Rands, W. H.
Roe, R. H., M.A. (Life)
Reid, Major D. E.
Ryan, Dr. J. P.
Ralston, W. V.
Raff, Hon. Alex. (Life)
Shirley, J., B.Sc.
Sutton, J. W. (Life)
Stevens, Hon. E. J. (Life)
Steele, T., F.L.S., F.E.S.
Sutton, Dr. A.
Slade, W. B.
Seabrook, G. K.
Scriven, E. G. E.
Sankey, Major J. R.
Schneider, Henry (Life)
Smith, Frank, B.Sc.
Turner, Dr. A. Jefferis
Taylor, Hon. Dr.
Thynne, Hon. A. J.
Townley, Capt. W.
Tonks, T.
Thomson, Dr. John (Life)
Watkins, Geo.
Weedon, Warren
Wasteneys, H.
Willcocks, G. C.
Walsh, Rev. W. M. (Life)
Young, Wm.
Zoeller, C.

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND.

VOL. XXII.

PART I.

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1909.

THE

Royal Society of Queensland.

Patron:
HIS EXCELLENCY LORD CHELMSFORD.

OFFICERS, 1909.

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CONTENTS.

THE

Royal Society of Queensland

Patron:

HIS EXCELLENCY SIR WILLIAM MACGREGOR,
M.D., G.C.M.G., C.B., ETC.

OFFICERS, 1910.

"THE JARDINES' EXPEDITION FROM ROCKHAMPTON TO CAPE YORK IN 1864."

By **HON. A. NORTON.**

Read before the Royal Society of Queensland, March 26th, 1908.

For the use of *Jardines' Journal*, and permission to write a paper on the subject for the Royal Society of Queensland, I am indebted to my friend, Alick Jardine. For the tracing of Cape York Peninsula, showing the course of their journey, I have to very heartily thank Mr. Spowers, Surveyor-General of Queensland, who, with his wonted courtesy, unhesitatingly consented when asked to have a tracing prepared in his office.

It was during Leichhardt's expedition from Moreton Bay to Port Essington, 1844 to 1846, that Gilbert, the naturalist, a collector for Mr. Gould, was killed by the blacks on the western side of Cape York Peninsula. Very little was known of that part of the country at the time (1845), but the aboriginals had shown a decided disposition to dispute any claim on the part of the white settlers to interfere with them, or with the country they occupied. In 1848, when Kennedy tried to reach Port Albany by keeping nearer to the eastern side of the Peninsula, the blacks asserted their rights with equal determination, and their hostility led to the death of Kennedy himself, when, with his blackboy Jackey, he had pushed on until almost within sight of the place at which they had hoped to arrive in safety.

Warnings such as these murders conveyed were in themselves sufficiently suggestive of what others might expect should they attempt to pass through the country which these hostile tribes claimed as their own. The Peninsula blacks had lived for years under conditions

which forced them to learn the arts of war. Malays, and other neighbours not less savage than themselves, had invaded their country and compelled them to fight for their rights continually; and what to them were the white explorers but invaders, who, if they had the opportunity would tamper with their women, and rob them of what they treasured most, if indeed they did not take their lives!

The whites who trusted themselves amongst them soon found this to their cost if they went unprepared. The dangers to which they might be exposed did not, however, deter some of Australia's sons from making their way through the inhospitable and exceptionally difficult country, which lay between the furthest north settlements and Cape York; and in 1864 the brothers Jardine, Frank and Alick, aged respectively 22 and 20 years, left Rockhampton with their party, intending to purchase cattle at the back of Bowen and drive them through to the newly-formed settlement which the Imperial authorities, on the recommendation of Sir G. F. Bowen, had decided to establish at Port Albany. A diary of their trip was afterwards compiled by their friend, Mr. F. J. Byerley, who, however, made some unfortunate errors in his narrative. It was not a Government expedition as he describes it, but was undertaken by the brothers as a private speculation, with the view of forming a cattle station near the new settlement from which they would be able to supply beef to the officials and their men, as well as to such trading vessels as might call in for provisions. As a matter of fact, the Government of the day were prepared to place a sum on the Estimates, after the trip had ended, to recoup some of the loss which the Jardines had sustained during their exceptionally difficult journey. This, however, they respectfully declined, giving as the reason that "inasmuch as the expedition was a private enterprise, and not a public undertaking, they did not consider themselves entitled to any indemnity from the public." At the outset the Government had offered, and the Jardines had gratefully accepted, the services of Mr. A. J. Richardson, District Surveyor at Rockhampton, and four blackboys with horses, saddles, and all equipments, to assist in the difficult task they had taken in hand. Mr. Richardson was to act as geographer, and generally to assist them.

Before continuing the narrative, I may explain that Mr. Jardine, the father of the explorers, was in 1864 Police Magistrate at Rockhampton, and when the Northern Settlement was decided upon, it was he who was appointed to take charge of it. The selection was an exceptionally good one, for Mr. Jardine had not only an extensive official and military experience, but he was a keen sportsman, and had a thorough knowledge of Australian bush life. Before he came to Rockhampton he had lived in the Wellington district of New South Wales, where he was the owner of a cattle station, the management of which was confided to his sons, Frank and Alick. Here it was they became acquainted with the ways of bush life; they looked after the stock, and when cattle were sold, they travelled with them to Bathurst and other places where they had to be delivered to the butchers who supplied beef to residents in the country towns. But, apart from the experience they gained in this way, they possessed in a high degree that instinctive knowledge which enabled them to travel through the trackless forest without deviating from the direct course, a feat which to most persons is impossible. The blacks who lived on the Upper Macquarie River were comparatively civilized when the Jardines lived amongst them, but the brothers were quite alive to the necessity of avoiding everything which would bring them into conflict with the treacherous savages through whose country they must necessarily pass when travelling through the unexplored forests of Cape York Peninsula; and they had too much discretion to provoke hostility which would greatly add to the difficulties and dangers they had to face in their northern journey. Mr. Byerley was under a misapprehension, therefore, when he spoke of Frank owning to "a feeling of savage delight at the prospect of having a shine with these wretched savages, who, without provocation, hung on their footsteps, dogging them like hawks all through the thickest of their troubles, watching with cowardly patience, for a favourable moment to attack them at a disadvantage." Indeed, throughout the journey, when they were at times compelled to act in self-defence, they allowed many of the aggressors to escape when they might have shot them down by dozens.

The party which it was decided should make a final start from Carpentaria Downs, the then furthest north-west station, and which belonged to Mr. J. G. Macdonald, was composed as follows:—Frank Lascelles Jardine, aged 22 years, leader; Alexander W. Jardine, aged 20 years, second in command; Archibald J. Richardson, Government Surveyor; C. Scrutton, R. N. Binney, A. Cowderoy, assistants; Eulah, Peter, Sambo, and Barney, blackboys.

On 14th May, 1864, Alick started with some of the party and a number of horses from Rockhampton, intending to travel overland by easy stages to Port Denison; Frank, with Mr. Richardson, went so far by sea. About the middle of July they moved forward; from Reedy Lake on the Burdekin, Alick, Richardson, Binney, and one of the boys went on with the horses and equipment to Carpentaria Downs, while Frank, with Scrutton, Cowderoy, and three of the blackboys went to Stenhouse's Station on the River Clarke, to collect and take care of the cattle which had been purchased. With these, 250 head of both sexes, they arrived at Carpentaria Downs on 6th October, and at once began to prepare for their arduous journey.

Alick, with his companions and the horses, had reached this station on 30th August, and, needless to say, had been cordially welcomed by Macdonald; but the five weeks' interval had not been an idle time for Alick, who, after a few days' rest, went off to explore the country through which they hoped to find a safe route for the stock, taking with him Eulah, their most trusted blackboy. Richardson and Binney were left at the camp. It had been supposed that the stream on which Macdonald had formed his station was Leichhardt's Lynd. It turned out to be a tributary of the Gilbert River, and Alick named it the Einasleigh; following this down, they passed over exceedingly rough country, but in places met with a good supply of water, in which were very fine fish. They sighted the Newcastle Range; and named Pluto Creek; Canal Creek; Parallel Creek; and Warroul Creek. In four days they travelled, as nearly as they could reckon, about 69 miles, almost all that distance being very stony, and extremely rough. It was not until they had ridden 180 miles that they concluded the so-called Lynd was not

that stream. During the last few days they had passed through better country, with plenty of water, and they had obtained game of various kinds, but it was not until 14th September, when they were on their return journey, that they saw any blacks. With these they were able to parley without any display of hostility on either side; the blacks were armed with reed spears and wommerahs. This day they also saw Leichhardt's "nonda" (*parinarium*) bearing ripe fruit. On 15th September, they passed some natives who were fishing; but the meeting was amicable; these used long heavy four-pronged spears barbed with kangaroo bones. The following day they camped in good feed for their horses, and caught some perch and other fish, and in the evening they hoped to add some 'possums to their larder, but these were very scarce, and their hopes were blighted. They, however, before they reached camp at Carpentaria Downs, were fortunate enough to bag a bustard, some native companions, and other game. They found all well, and Alick employed himself in mapping the country which he and Eulah had traversed; he was unable, however, to persuade Richardson that they were not on the Lynd, he trusting to the incorrect map received from the Surveyor-General's Office rather than to that which Alick Jardine had correctly plotted. This difference of opinion led to some friction between the brothers and the Surveyor. It is due to Mr. Richardson, however, to state that he afterwards admitted he had been in error.

Now, however, the arduous part of the journey was about to begin, and the exploration of the Einasleigh watershed gave some idea, though but a faint one, of the difficulties that must be overcome before the brothers could shake their father's hand; for Mr. Jardine, senior, and his youngest son, John, had gone to Port Albany by water, and were at this time busily engaged in forming the new settlement, the Imperial Government having sent out a detachment of marines who were to be stationed there, and assist in the work.

As already shown, the party consisted of six whites and four blacks (troopers). It had been calculated that four months' provisions would be required, and in addition to this loading, they had to take with them tools, ammunition, and camp necessaries. The boys were armed with

double-barrelled police carbines, the whites with Terry's breech-loaders and Tranter's revolvers. To carry so much dunnage they had eighteen pack-saddles, and for all purposes they took with them forty-one horses and one mule, all of which must be shod before they could start. Then it was found that only Frank and Alick Jardine knew how to shoe a horse, and a number of these had not previously been shod. However, with the thermometer marking 100 degrees in the shade during most of the day, they set about the work, and at the close of the third day the last was finished. On 11th October, Cowderoy, with Eulah (who had been over the country with Alick Jardine) and Barney were sent off with the cattle; their instructions were to camp at the swamp at the junction of Pluto Creek, 17 miles from Macdonald station. The rest of the party were fully occupied in fixing up the packs and getting away with the horses, a number of which stoutly objected to carry the burdens which they were required to bear. It was past noon when they got off, and night had set in when they arrived at the swamp. Alas, however, neither Cowderoy and the boys nor the cattle were there! It afterwards transpired that Eulah, smart as he generally was, had led them some miles away from the course they were to have taken, and, becoming completely "bushed," they had to camp for the night a long distance from the swamp. By the time the brothers had found them next morning, and brought them to the camp, it was too late to make a fresh start. The distance travelled on each of the two following days was 11 miles, for grass was very scarce, large patches of it having been burnt by the natives. Besides this, they had to take the stock over miles of rough, stony country in which good water was by no means abundant. They were glad, therefore, on 15th October, after 9 miles travelling over comparatively good and well-grassed country, to fix their camp at Cawana Swamp, which is described as being about 6 miles in circumference, and very shallow. Some natives, who moved away when the cattle approached, left their camp fires burning. An observation taken at night gave the latitude 18 degrees 1 minute 50 seconds.

After they left Cawana Swamp the travellers were compelled to cross very stony basalt country, which lamed their cattle and wrenched the heads off the horse-shoe

nails. Alick Jardine shot and brought a welcome addition to their larder—a rock wallaby, a native companion, and a young red kangaroo. For a time it seemed probable that they would have trouble with the blacks, of whom about 50 men, painted and fully armed, followed on their track; when turned upon, however, they hastily retreated. Next morning all the horses were missing, having made back, after the previous day's weary travelling and starvation, towards the last luxuriantly-grassed camp. Bad, however, as the country had proved up to this time, it now became more and more difficult. On 17th October, one of their best horses had injured a hoof very severely, and two cows fell from the rocks and were killed. What grass there was was dry and very poor, even in the bed of Parallel Creek, where they camped for the night, and on the western side a basaltic wall 80 feet in height barred all progress in that direction. Nor was there any improvement next day; perpendicular cliffs on either side compelled them to travel down the bed of the creek, where there was almost no grass, and in which great blocks of stone impeded the passage of the stock, the backs and feet of which were "in a woful plight." One horse was lost, and a bull and several of the cattle completely knocked up. This day they saw a large number of natives, some of whom were cooking fish, which they left in alarm, and also their arms. "These blacks were puny, wretched-looking creatures, and very thin. They had a great number of wild dogs with them—over thirty being counted by the party."

On 19th October, they came to the junction of Parallel Creek and the Einasleigh; and, happily, there was a slight improvement in the country. The river at the point where they camped is described as being "about 700 yards wide, with fine waterholes in it, containing plenty of fish." At a blacks' fire here they made a startling and gruesome discovery—"the fresh remains of a negro were found *roasted*, the head and thigh bones were alone complete, all the rest of the body and limbs had been broken up, and the skull was full of blood." One day more, and for a time they had done with the stones, and grass and water were abundant. They now came to the finest country the cattle had been on since delivery was taken of them,

230 miles back; they therefore decided before the good country was left, to camp for some days. "Many of the cattle were lame, two of the hacks were knocked up, and several of the pack-horses had very sore backs." They were 120 miles from Macdonald's, and had averaged 10 miles a day since the start.

While the stock rested, the brothers explored the country through which they hoped to find an easier route than they had so far followed. Richardson still adhered to his theory about the Lynd, which he placed about 10 miles north-east of their camp. They were even more satisfied, however, after their 25 miles ride on 24th October, that he was mistaken. They returned to camp after four days' hard riding, having blazed on the last afternoon a line 18 or 20 miles for the cattle to follow. Again they started with Eulah to explore, leaving instructions that the cattle were to go forward on 31st October, following the line they had blazed for their guidance. They took no meat with them, trusting to find game and fish by the way. One delicacy which provided them with "a good supper and breakfast" was an iguana. After six days' absence they rejoined their party at the place appointed, but on neither of their expeditions had they found even a moderately good route for the stock; they therefore decided to take the course which seemed the least unpromising. From this time their troubles seemed greater than ever. When they left the camp, as they now had to do daily to blaze a line for the cattle to follow, 16 horses were missing; one other had died from what appeared to be snakebite. When night closed in there was no word of the horses, but one of the boys who brought them rations reported that some were still missing when he left the camp. Three more days passed, and yet no news, but more than 20 of the cattle were missing, and as matters were getting serious Alick decided to go back and ascertain what caused the delay.

The ninth day of November brought disastrous news. Alick started back in the early morning, and the men with the horses, which had strayed, met him half-way. On the afternoon of the day when the brothers moved on with the cattle (5th November), through want of reasonable precaution, the grass around the camp had taken fire.

The result was more than serious—420lbs. flour, all the tea except 10lbs., the mule's pack which comprised 100lbs. rice, and jam, apples, and currants, 5lbs. gunpowder, 12lbs shot, cartridges and caps, two tents, one pack-saddle, 22 pack-bags, 14 surcingles, 12 girths, 6 breechings, 30 ring pack-straps, 2 bridles, 2 pairs blankets, 2 pairs boots, most of the blackboys' and many of the brothers' clothes, and 2 bags containing awls, needles, twine, etc., were burnt. Then, too, a valuable horse died, apparently from poison. Such was the news which was brought to the camp on Cockburn Creek, 16 degrees 55 minutes 6 seconds latitude, on 9th November, 1864! Half their food and the greater part of their equipment had been burnt, but the hearts of the brothers never failed, and they at once began to make their preparations for a forward move on the morrow.

On the morning of 10th November, the brothers, taking Eulah with them, started as usual to blaze a line which the men with the cattle were to follow. The country was sandy, scrubby, and barren, and at 25 miles they marked a place for the party to await their return. Some miles further down Cockburn Creek they struck away N.N.W., and camped on the head of Maramie Creek, so-called because of the number of cray-fish caught there. Hence they ran Maramie Creek down, but without finding any improvement, nothing but a waste of tea-tree and spinifex on both sides; the blacks had used the bark of a small acacia for poisoning the fish in all the waterholes. They continued to explore until 15th November, during which time they had travelled through most worthless country, but discovered that the Staaten of Dutch explorers was the lower part of Cockburn and Maramie Creeks. The blacks had threatened, but did not attack them.

The following day the cattle were moved down Cockburn Creek on which there was poor grass, whereas elsewhere there was no grass. Deaths of cattle and horses from poisoning were now becoming frequent, and although water was plentiful the country was execrable, most of it being flat and thickly covered with tea-tree and other timber denoting poor country. On 20th November, the blacks for the first time attacked the party; they approached from the west just before the sun set, so that the attack

could not be easily seen ; none of the party were wounded. After this they were continually harassed, the most serious outcome of the interference being the scattering of horses during the night. This caused a detention of six days at one camp, and from it eight head of cattle were lost, and had to be abandoned. For several days they continued to travel down the river, where the grass was somewhat better, until they reached saltwater. Here they killed and jerked a beast, and a shovel-nose shark was similarly treated. Frank lost his only dog a few days before this.

By reason of absence of feed for the stock, they were compelled to keep away from the course they wished to follow, but necessarily they must now keep the coast on their left. And time was very precious, for the wet season might set in at any time, and after even one storm the ground became dreadfully boggy. They knew they might be shut in amongst the anabranches, and for miles the flat country showed high flood marks. On 5th December, they moved forward, this time steering northward across flat tea-tree country with fairly good grass, but almost without water. Half the horses were missing next morning, and the whole day was spent in trying to find them. Some of them the brothers tracked to their last camp, but they had to stay there for the night as darkness set in before the whole of them were found. Without food or blankets they spent the night battling with myriads of mosquitoes. When next evening they reached the camp with the nine horses they had found, only two others had been brought in, and the mule with his pack had been allowed to stray. He was never secured, although one of the boys once caught sight of him. Two of the best horses were lost from the same camp, one of them, like the mule, having gone mad, apparently from drinking so much salt water in the absence of fresh ; the other had died it was thought from the same cause. At this wretched camp eight days had been lost, and on 13th December the party had to move on, but with the mule's pack they had lost all that remained of their tea, currants and raisins, their spade, tomahawks, axes, shoeing tools, etc., and two pairs boots, the only ones the brothers at this time possessed. This day their route took them across large marine plains on which were numbers of birds, of which they shot a few. They camped at night

on good fresh water with good grass in the bed of the creek. Latitude 16 degrees 3 minutes 38 seconds. Next day the character of the country was still the same, but hot winds had dried up the grass. Then after a stage of 23 miles, with country somewhat ridgy and a better class of timber, they camped on Eulah Creek with abundance of good water and grass. On 16th December, the country became more difficult; wide stretches of flood-marked levels and a creek which was so thickly lined with scrub that the brothers had to clear a track through for the cattle. While here they were attacked by blacks, who made a circle round them and forced a fight, but they were driven off. When exploring the country ahead in the afternoon, the brothers came upon the long-sought Mitchell River.

For some days they travelled down the river, crossing flood-marked flats and numbers of anabranches; but 18th December was a memorable day, the party having been attacked by a large body of natives, who at first showed signs of great courage; after some trouble and no small danger they were driven off. Three days later another mob appeared; these carried green bushes behind which they attempted to approach the whites without being observed. This time they turned and fled, the whites chasing them without firing a shot, and then carrying off the spears which in their flight the blacks had dropped.

When the travellers left the Mitchell on 22nd December, they had decided to begin the straight running for Cape York. In such country at this particular time of year, however, those who travel must take such course as is possible. Their first day did not turn out well; there had been more rain than they wanted, and their camp at night is described as "a puddle without a blade of grass," for the verdure which from a distance looked so promising was nothing but a dense mass of small green tea-trees about six inches in height. They had had no meat for three days, so they killed a steer and feasted! They jerked the meat as best they could, for the rain came down heavily, and they watched the cattle and horses. Notwithstanding the rain, they had no water at the next camp, for the sand being exceptionally dry, no water lay on the surface. Nor was there any grass. Next day there was very little

improvement. but it rained all night, and on Christmas Day Frank wished his companions the "compliments of the season," and pushed on through the downpour. Christmas Creek was named this day; the country was somewhat better and they found a place to camp where there was good water and abundance of blue grass; green tree-ants were also plentiful, and caused them great discomfort. Up to the end of the month, although the country was on the whole better, the deluging rain was most trying, and one thunderstorm was especially violent. The blacks on 29th December rushed and scattered the cattle and horses, and chased one of the boys. They were driven off, but 10 of the cattle were lost on this occasion. They dare not delay on country the whole of which might be flooded several feet at any time. On the last day of the month the stock and packs were safely conveyed across Macleod Creek, and they camped on slightly rising ground on the bank of Kendall Creek.

The New Year brought little relief to the wayworn travellers. The cattle and horses had to struggle through scrubby country, and over the large trees which had been laid low by the recent terrific storm; but storms with heavy thunder and pouring rain were of almost daily occurrence. The ground was boggy, and the creeks and watercourses were running strong, but on 2nd January they had what they describe as the best camp of the journey on a high plateau. On 5th January, they sighted a range about 10 miles distant, and between them and it was a fine valley intersected by a large sandy river which they named after their friends, the Archers, of Gracemere. Why the Survey Department should in later maps call it the Archer *or Peach* is to me a mystery. Surely they might pay the intrepid young explorers the poor compliment of retaining the name they gave it, and refusing to recognise it by any other. Mr. Spowers, our present intelligent Surveyor-General, I hope will correct this. The valley is described as one of great richness and beauty, the best country seen since passing Broadsound. They seem to have crossed the Archer without any exceptional difficulty, notwithstanding its width and the scrub which lined both banks. The flowers which grow in abundance in this valley are referred to as being very beautiful and comprising

a number not previously known to the explorers. Leichhardt and other handsome trees were numerous.

Unhappily, this pleasant condition did not long continue, for the country they passed through after getting clear of the Archer and its anabranches, was comparatively poor and waterless but for the showers of rain. Its sandy, porous character is suggested by an extract from the *Journal* :—" It was strange to see the horses bogging leg-deep during a thunderstorm, and in five minutes after unable to get a drink of water." They had seen many anthills in this northern land, but here they were in some instances as high as 18 or 20 feet. As they passed on, keeping as nearly as possible a northerly direction, the country was on the whole better, but at night on 8th January, after, for three miles, passing through "wretchedly bad country like that on the Staaten, they camped on a 'gilgai,' and had another night of heavy rain with high wind." No wonder two more of their horses knocked up! But the difficulties they had so far experienced became more and more aggravated. They struck the Coen River, running W.N.W., and had to cut a road for the cattle through the thick scrub on either bank. This river is described as being 60 yards wide, sandy, and the home of crocodiles, the country on the north bank being very bad; but worse troubles were ahead of them.

On 10th January the country was comparatively sound for two miles, at which point a narrow boggy creek running strongly through a tea-tree flat intercepted their course. I will here quote the *Journal* :—" Athough care and time were taken in the selection of a proper spot, when the herd began to cross, the leading cattle, breaking through the crust, sank to their hips in the boggy spew below, and in a short time between 30 and 40 were stuck fast, the remainder ploughing through with great difficulty. Four beasts refused to face it altogether, and it was found necessary, after wasting considerable time, and a deal of horseflesh, to let them go. The greater part of the day was consumed in dragging out the bogged cattle with ropes." Five head had to be abandoned, their heads and backs only being visible above the mud. "The horses were more easily crossed, but their saddles, packs, and loads had to be carried over by the party." They at once

camped and spent the rest of the day in drying their arms, saddles, etc., and in jerking the beef of one of the beasts which they had been unable to rescue from the bog. At night they again had heavy rain. On the following day the brothers slushed ahead of the cattle for two miles to the Batavia River, which was "a banker," 25 yards across. By the time the cattle overtook them, they had cut a track through the scrub on either bank and had also felled a tall melaleuca acrcss the stream ; by means of this impromptu bridge, above which a guiding rope was fastened, they were able to carry over the saddles, stores, etc., on their heads. The cattle they got safely across with the exception of one cow which was drowned, but in spite of all their efforts, two horses were also drowned. They were obliged to abandon their intention to push forward, because of the bogginess of the country and the continual rain, and they camped rather higher up the river.. They went on the following morning after some of the horses which had been left in the bog. These they brought to the camp where further misfortunes awaited them. To their dismay they found that a number of horses had been poisoned ; five of these died the same evening, and another, supposed also to have been poisoned, was missing. One effect of the poison was complete blindness, and the fattest were the first affected.

Having now only 21 horses, and these the poorest and worst, they buried a number of horseshoes, nails, and heavy material and redistributed their loading ; the rain continued all day. In spite of all their difficulties they camped next night 10 miles away from Poison Creek. The journey was not easily got through, for the horses had to be driven with the cattle, while the explorers, trouserless and bootless, had to walk. Some of the horses were unable to reach the camp, but these were brought on next morning. They had to exercise the greatest vigilence, for the blacks were hanging on their tracks. This day was a repetition of the last, horses having to be dragged out of bogs, packs removed and carried over the running streams, and at its close two more horses dying from poison! It poured with rain as they pitched their camp, and while doing so the blacks attacked them ; they were easily driven off, however, only two shots being fired, and they were not further

troublesome. Sunday, 15th January, was observed as a day of rest, and the exploiers feasted upon doughboys, jam, and "stodge," made of flour and water in which some small pieces of raw meat were boiled. Another horse was poisoned, and a cow lost in the bog; they had more rain at night. Their spare time while it was light was occupied in picking pandanus thorns from their feet and legs. Willingly would the brothers have rested but for the urgent necessity for getting to the end of their journey. They had to refuse all appeals to remain longer, and through a dense undergrowth of vines, zamias, and pandanus they pressed forward. They had no meat, and it was useless to kill a beast, because they could carry nothing more. One more horse died, and two others could scarcely drag themselves along; they had to unpack only twice this day, and travelled 16 miles. On 17th January, they pressed forward through country somewhat better than they had lately seen; distance 15½ miles to their camp on Skardon Creek. The two weak horses died. At this point, by their reckoning, they were near Kennedy's track on the eastern watershed. The improvement they hoped for did not last, next day's march being through loose white sandy ridges, covered with low bushes thickly matted together with prickly vines, without trees and without grass. The creeks crossed, which ran W. and N.W., were full of water; they were very boggy, and could only be crossed at their heads. A foal, whose mother had previously died, knocked up, so they killed him, and part of his flesh which was carried on, "was a grateful addition to their food"; the distance travelled was 12 miles. The horses were short-hobbled at night and watched; still they got away, and a late start next morning was the consequence. The country was again execrable in every respect.

On 20th January, the way was blocked by a dense and extensive scrub through which it was impossible to cut a track for the cattle; these had to be driven 2 miles back and then taken in an easterly direction. This took them on to the eastern slope from which the sea was distinctly visible; after a very arduous day's work they struck a patch of better country, well grassed and lightly timbered. Here they pitched their camp, having travelled 9 miles to reach a spot 1½ miles from their last camp. Plenty

turkeys' nests were found, but, although they welcomed foal's flesh as a delicacy, few of them were equal to turkeys' eggs in which the young were well advanced! The next five days were but a repetition of the preceding ones, bad scrubby country without grass, intersected by deep water-courses which were then full of rushing streams; dense vine scrubs through which a track had to be cleared for the stock; miserable camping places, and pouring showers of rain day and night. On 26th January, they came upon a river which they took for the Escape; it was in flood at the time, and 50 yards wide; following it down 7 or 8 miles they came upon an equally large branch which joins it from the south-east, and named it the McHenry. This, too, was in flood, and they camped about a mile above the junction. This day their sugar was exhausted, but they hoped they were not more than 30 miles from the new settlement, Somerset, and did not mind very much.

On the morning of 27th January, they swam the cattle over the McHenry without trouble; the saddles, packs, etc., had to be carried on the heads of the best swimmers, and the day's march was exceptionally tedious. Following the stream down to its junction with what they mistook for the Escape, they had to swim most of the creeks for the rain continued without cessation. Below the junction was a large vine scrub so dense that they had to skirt it, the combined streams being now 100 yards in width, and all the creeks and gullies which fell into it were fringed with scrub; 5 miles was the extent of their day's march. Following on down the course of the river, the flooded creeks and their scrubby lining made travelling most difficult; they therefore struck westwards hoping to find an easier route; but they were again disappointed, and turning towards the river they struck it in about 7 miles. Further down by about 4 miles, making 12 miles for the day, they camped on the river bank. It had rained all day and here the stream was 150 yards wide. They killed a lame heifer, and cut up the flesh for jerking. Two horses were left utterly knocked up, but these were brought in on the next day, which was observed as "a rest day." The stores were overhauled, and it was found that the greater part had rotted from constant exposure to the damp. Mr. Richardson here plotted up the route, and

reported that their camp was on the Escape River, eight miles in a direct line from where it joins the sea, and sixteen miles from Somerset. In this case, as in that of the Lynd, he was altogether mistaken.

Leaving the rest of the party at this point, the brothers with Eulah started down the river on 30th January in search of the settlement. They took with them 25lbs. flour and 12lbs. meat as rations for a week. The country for travelling was execrable, and before noon the rain once more began to pour. Then the river turned sharply to the west, and they were forced to the unwelcome conclusion that it was not the Escape ; for protection from the incessant rain they ran up a gunyah of tea-tree bark and decided, in deference to Mr. Richardson, to follow the course of the river still further on the morrow. When they started next morning they found no improvement in the country ; the continual rain had increased the flood waters ; the ground was more boggy ; the swamps, anabranches, and lagoons were more numerous. After travelling 10 miles, another large stream from the south-east, which they named the Eliot, blocked the way. This they waded safely with the water up to their necks ; their saddles and packs they carried on their heads ; 7 miles further on they camped for the night on the river bank. Next morning they tried the river for another 7 miles ; then, as it kept turning more and more towards the west, they felt even more certain that it was not the Escape River, and turned back on the track by which they had come, camping at night in their tea-tree bark gunyah ; rain, accompanied by cold winds, had fallen all day. When they reached the camp they found all well ; but the flour was 30lbs. short, and, as always happens on such occasions, nobody could imagine what had become of it ! Being almost without flour, and having to depend upon such game as they could secure to supplement the jerked beef, they were most anxious to push forward, but one day was spent in searching for a practicable crossing of the river which was now wide and deep and rapid. The continual rain flooded it still more and detained them another day ; they therefore killed another beast for rations. Richardson, after making further observations, decided that they were 33 miles south of Cape York. During the day they constructed a small raft,

the frame being dead Nonda wood, which is light, and across this they stretched and bound a hide. Although the water fell considerably in the night, the stream was still 130 yards wide, the current ran swiftly, and the banks were lined with scrub ; however, they swam 4 horses safely over and then floated the saddles and rations across on the raft. The brothers and Eulah, who were to go in search of the settlement, camped on the north side, Scrutton and the others remaining with the cattle.

On 6th February the little exploring party pushed on in a N.N.E. direction, and, after many difficulties, at 20 miles, they looked down on the sea about half-a-mile distant. This was Newcastle Bay. They went three miles further on and camped on a palm creek, with very steep banks. Following along the coast next morning at 7 or 8 miles, their course was blocked by what proved to be the Escape River. This they followed up through country that was indescribably difficult, the saddles at each of the numerous creeks having to be carried on their heads and a passage cleared with their tomahawks through the scrub. At last three of the horses completely knocked up, and they camped in the open. The brothers walked on until they came near the river ; only near it though, for on either side there was a dense mass of mangroves nearly 3 miles in width. Their rations now consisted almost wholly of jerked beef, and they rejoiced that evening at finding 13 scrub-turkey's eggs. "Eating what yolk or white they contained, they plucked and roasted the chicks as a *bonne-bouche.*" They and their horses were tormented by March flies and sandflies by day, and by mosquitoes by night. This day they travelled 22 miles. Wearisome as their journey had so far been, it was not less so on the two following days ; for although they could now see their destination, there was no hope of getting through the mud and mangroves which shut them off from the river banks. It was decided, therefore, to return to the cattle, and take them by a course which they hoped would lead to a practicable crossing higher up the stream. So bad was the country they now traversed that they made only 12 miles, having to drive their knocked-up horses before them, and several times to drag them out of bogs. On the following evening they got back to camp after another most fatiguing day ;

they left their jaded horses and their saddles near the river, and themselves swam across to their companions. Another horse had died during their absence.

Two days they now spent in camp and a beast was killed and the meat jerked; only 10lbs. flour remained, and this was kept in case of an emergency. The 4 horses, saddles, and swags were brought across the river, and the cattle mustered for their next start, which took place on the morning of 14th February, a weary journey of 11 miles. Another horse had to be left after he was dragged out of a bog. On the following day they crossed the Eliot, and altogether made 10 miles, having had to carry their saddles over on their heads as usual. From this point they continued with much difficulty from flooded streams, bogs, etc., to follow down the river, uncertain whether or not it would bend round into the Escape; but on 21st February, from a high tree Alick was able to trace it to the sea on the Gulf side of the Peninsula. By Sir George Bowen's request, later on, this stream was named the Jardine River. This geographical discovery, however, necessitated a retracing of their steps, and at night they camped 6 miles up the river. They rested on the following day, and killed and jerked a beast; again, on account of the heavy rain, they had to construct a raft. On 24th February, the horses and packs were put across the river, and leaving the cattle with the rest of the party, the brothers with Eulah camped on the northern side preparatory to starting once more in search of the settlement. More trouble awaited them, for at 2 miles from their camping place an immense sheet of water, the overflow from a heavily flooded creek, blocked their way, and it was not until after two days that it had run down enough to enable them to cross, even by swimming. The horses they swam with the saddles on their backs, but the rations they slid along a rope which was fixed some feet above the ground to a tree on one side of the creek and to the butt of another on the opposite side. In the evening while Alick was cooking some jerked beef for supper (they usually eat it raw), Frank and Eulah climbed a high tree on a small hill, and from this they were able to pick out Newcastle Bay, and were moreover satisfied that they had headed the Escape River. At last they were

within a short distance from the goal they had so long looked forward to reaching.

On 1st March, they started early, the morning being wet as usual. At 3 o'clock they met with a number of blacks, who spoke some words of English, and greeted them with friendliness. These were made to understand that they wanted to be guided to the settlement, "Kaieeby," they called it, and they led the way for about 7 miles, when they joined a larger number of natives, all unarmed. With these they camped for the night. Whether the corroboree that was then held was intended as a welcome, or meant a rejoicing in anticipation of a repast on human flesh, they did not then know, but about midnight the din ceased and their dusky friends went to rest. About noon their guides brought them safely to the settlement, and surrendered them to their father who had long expected them, their younger brother John being with him. With skin tanned by the sun, coverings of emu feathers on their heads, greenhide mocassins on their feet, and such remnants of clothing as would hold together on their bodies—with such outward but grotesque adornments—they were received with joy and gladness. Since their father had seen them they had travelled over 1,600 miles through country the greater part of which was practically unknown, and they had brought with them, and in good health, all the men who were in their care. But their losses of stock had been great, and the difficulties, hardships, and dangers which they had encountered and overcome, have scarcely if ever been surpassed by those of any Australian explorer.

The rest of my story may soon be told. After enjoying, in the companionship of their father and brother John, the first decent meal they had had for months, the brothers manned the Government whaleboat and pulled across the Straits to Albany Island to get fresh horses. The Straits are ¾ mile wide, and the current was strong, but they brought two horses over that evening, and three more on the following day. They also chose a spot at Bullock Point, about 3 miles from Somerset, for the head station of their future run. Then they rested two days, more on account of their jaded horses than on their own. Taking these as well as the fresh animals with them, they started back under the guidance of two of their newly-found dusky

friends, their brother John also accompanying them. They were taken by a course which was generally better than that they had come by, but the last two miles of their day's journey were so boggy that even the fresh horses stuck occasionally. On 6th March, just before dark, they pulled up on the river opposite the camp, but as soon as they got out of their own country the new boys were useless as guides, and the brothers had to pilot themselves. They crossed to the camp next morning; one horse had died during their absence, and some of the cattle were missing. This necessitated further loss of time, and three of the cattle could not be found. However, they built a raft similar to that made before, but larger, and they killed a beast for rations. The river was still 200 yards wide when they commenced the business of crossing on 9th March; the cattle with one exception, they got safely over, and also the horses. The raft answered admirably, but on the last trip, Cowderoy, who could not swim, was put on board. Unfortunately, he overturned it, and although he got ashore safely, the raft and all it carried, went to the bottom, and was recovered only with difficulty. The Cape York blacks decamped during the night. In crossing the creek, which had blocked the brothers when they started in search of the settlement, and which they again had to swim, they lost yet another horse. Still their ill-luck followed them, for it took them two hours on the following day to drive the cattle through the scrub on Wommerah Creek, and when they were counted, 30 of them were missing: of these, five were not recovered. At last, on 14th March, they arrived at Bullock Point, where they pitched camp, and made a home for those of the cattle which were left to them. When the necessary work of forming the station had been completed, John was left in charge of it, and Frank and Alick returned with their father to Brisbane in H.M.S. Salamander. Mr. Richardson returned by the same opportunity, and in the Surveyor-General's office occupied himself in compiling a map showing the route they had followed; in this the error in connection with the River Lynd was rectified.

My tale is told, and in conclusion I desire only to add that when I read of the splendid and fearless achievements

of such young Australians as Frank and Alick Jardine, I feel inclined to thank God that I too was born in this "fifth quarter" of the globe, and entered upon the business of life while the "eight-hours-a-day" man was but a figment of the human brain.

THE PEOPLE OF NEW GEORGIA. THEIR MANNERS AND CUSTOMS, AND RELIGIOUS BELIEFS.

By the REV. J. GOLDIE.

Read before the Royal Society of Queensland, July 3rd, 1908.

In these days everybody is more or less acquainted with the islands of the Eastern Pacific, and with the manners and customs of the people inhabiting those islands. With the islands of the Western Pacific, however, travellers are not so familiar, and, perhaps, one of the least known of all the groups in that part of the world is the great group of islands known as the Solomons. This fine group of islands lies between 5 degrees and 10 degrees S. Lat., and 154 degrees and 162 degrees E. Long. The length of the group is well over 600 miles, and many of the larger islands are very mountainous, some of their peaks rising as high as 10,000 feet.

The people of this group are pure Melanesians, and have all the characteristics of this type. It is not for me, however, to advance my theory as to the peopling of these islands, or attempt any system of classification. Better men have failed to agree about these things, and though intensely interesting, we have not time to discuss them to-night. What I can speak with authority on, and what no doubt you will be interested to hear about, is the manners and customs of some of these people, and something about their religious beliefs. I have lived amongst the people of New Georgia for the last six years, and therefore may fairly claim to know a little about them.

FORM OF GOVERNMENT.

The form of Government is that of hereditary chieftainship. Over each village is a headman—called by the natives "Palabatu"—the same word as is used for "husband." The villages are divided into groups, and over each group is a chief called by the natives "na Bagara"—a man of much more importance than the headman or "Palabatu." Sometimes the man who has the right to these positions is a weakling, and has little or no influence. Or perhaps a man of no family, but of very strong character, will overshadow him, and will really exercise a greater influence than the "Palabatu." But though the common people will look upon him as a kind of leader, the other chiefs will refuse to recognise him as one of themselves, or will do so very reluctantly. They speak of him in terms of the greatest contempt as "having no father." Human nature is much the same all the world over. Over a big district, or over one of the islands, reigns the principal chief, or "Gati-Bagara." "Gati" is literally "trunk" or "stem," and thus this chief is the real or hereditary chief, and is generally a man of great importance, and if a man of strong personality exercises a wide influence, and possesses almost unlimited power in certain directions. Sometimes the influence of one of these strong men will extend far beyond the bounds of his own district, or even of his own island, and thus his village becomes the political centre of that part. Such a one was Ingava, the chief of New Georgia, known to all the naval officers and traders who have been in that part of the world.

Generally speaking, the communistic system prevails—land, houses, canoes, and produce all belonging to the community, and not to any particular individual. Since the advent of the white trader, however, this system has been greatly modified. In the way of trade they are often persuaded to purchase from the trader things that they don't really require, and thus a debt is incurred for which some individual is made responsible. Other individuals in the same tribe will run into debt also, and to settle these when the trader asks them to pay up, private claims are made to what was once public property. Thus cocoanut

trees, sago palm plantations, canoes, and even the land pass into private hands. To protect his property, and prevent others who think that they have as good a right to it as he has, a man will trade on the superstitious fears of his fellow villagers, and put a "tambu" upon the property he has claimed. This "tambu" takes several forms. If it is on a piece of land, it is usually a stick split at the top, with the leaves of a certain tree inserted. If it is a particular tree they wish to preserve they tie a piece of the sacred vine round the stem, and a native seeing this will not touch it, for fear of bringing down upon his head the wrath of the spirits. But more about this later on.

On most of the larger islands there is unceasing hostility between the "bushmen" and the "salt water men," as they are called, as well as between the tribes inhabiting the different islands. This will show how little ground there is for fear of anything in the nature of a general rising, as was reported by a trader from the group a few days ago.

The "bushmen" protect themselves by building their villages on the tops of the hills, and some of their positions are so well chosen, and the places so skilfully fortified, that it would be a difficult task even for a force of well-trained men to take them if properly held. I visited one of these fortified villages two years ago. It was situated at a place called "Kumboro," on the S.E. end of the Island of Choiseul, and at the top of a peak about twelve hundred feet (1,200ft.) above sea level. I was the first white man to visit the place, and it was with considerable difficulty that I persuaded the chiefs to allow me to go. After climbing—sometimes on all fours—up the mountain side, wading through streams, and getting many a tumble—losing the skin of my shins and hands in the process, I at last, after a three hours' journey, arrived within hailing distance of the village. It was right above us, and was a great circular enclosure, taking in the whole crown of the hill, and entirely surrounded by great stakes, pointed at the top, about fifteen feet high, and about a foot or more in diameter. These were placed as closely as possible together, and at such an angle that anyone coming up the mountain side would be right underneath the stockade. Inside were walls of rough stone, forming

a very effective defence against the attacks of the raiders from below. Inside the stockade I found about fifty or more houses. It was with evident reluctance that I was allowed to enter the village, and only after the guides had convinced the people that I possessed supernatural powers.

These defences are very necessary on account of the raids made by the headhunters of Rubiana and other places. These raids were made in order to secure heads for the dedication of new houses and new canoes, and to obtain victims for the cannibal feasts and sacrificial rites performed from time to time. These people are the slaves of superstitious fears, and these superstitions were worked for all they were worth by the old sorcerors and witch doctors. If a house were built it would be necessary for the preservation of its inmates to propitiate the spirits by shedding blood, and the obtaining of a number of human heads. If a new "tomoko" or war canoe were about to be launched, the sprinkling of human blood and obtaining of heads would invest it with supernatural power. Therefore these raids were organised by the sorcerors, and in their beautiful war-canoes they would travel sometimes over two hundred miles to kill and obtain heads. Before making a start the chiefs pay a visit to one of their many sacred places—generally the shrine of some of their ancestors—and there make sacrifices, and offer prayers to the spirits for help in their raiding operations. With great ceremony they then embark—carrying with them in each of the canoes a sacred relic or charm—as a rule, a small bone of some once-noted warrior, since deceased. Their mode of warfare is that usually adopted by natives of almost any place—taking their enemies by surprise, and killing them before they have an opportunity of defending themselves. Their operations, however, are carried out with an unusual degree of cunning and skill, for they generally try to create the impression that they intend to raid a place to which they really have no intention of going, and after turning all eyes towards that particular place, they suddenly swoop down upon some other unfortunate village, and, catching the inhabitants unprepared, kill and capture to their hearts' content. On their return to their own village they are received by the women and girls singing and dancing to welcome them home. Immediately

they land another visit is paid to the sacred place, and offerings of food, ornaments, and sometimes of human flesh, are made to the spirits in return for their assistance in the raid. Immediately after these religious observances, a great feast and dance is held—or rather, preparations are made to hold it, for it generally occurs some days after—to celebrate the victory over their enemies. These people are cannibals, and if victims for their feasts could not be obtained in the raid, then so much the worse for some unfortunate slave captured in some previous expedition.

With regard to slavery—the lot of the slaves captured in these raids is not an enviable one. While they are treated with kindness, and the work they are expected to do is not heavy or difficult, they are the absolute property of their captors. The women, in addition to having to do the work, are nearly always used for immoral purposes, and thus become sources of profit to their owners. Then there is always the dread uncertainty about the tenure of life. When a head is required to pay for some affront to a neighbouring village, or a life to be sacrificed on some occasion of great ceremony, the unfortunate slaves know that, without warning of any kind—often after helping to prepare the feast—their own life may be taken from them by a sudden blow from the axe of one of their masters. Still I have known cases where the female slaves have become the wives of their captors, and have been treated with as much consideration as the women belonging to the tribe—which is perhaps not saying much.

The marriage laws of these people are very simple. The wife is acquired by purchase. When a man makes a proposal for the hand of the girl of his choice, or when—as is very often the case—a girl makes a proposal for the hand of a young man, a meeting of all the friends takes place, and a price is fixed, which must be paid by the man before the marriage is allowed to take place. This price is regulated by the position occupied by the parents of the bride, and as it is always paid in native money or ornaments, it is very hard to say what their value would be in English money. In the New Georgian Group of Islands it is not the custom to have more than one wife, though I have known several cases where a chief has had more than one. This happened where the first wife was getting

old and helpless, and the man required someone to do the work for him—for the women are always the drudges of the men. In the Shortlands, and in the Islands of Bougainville Straits, however, the chiefs and leading men almost without exception have more than one wife, and some as many as ten or twelve. As a rule, the wishes of the girl are not consulted in the matter, if her friends decide that an alliance with a certain young man is desirable, and if she causes any trouble they get very angry with her. Sometimes, however, the youth refuses to pay the amount agreed upon until the girl consents, and sometimes if the fickle lady changes her mind after the payment, which sometimes happens, there is a big row, for there is no law compelling the return of the money. When everything runs smoothly they hold the marriage feast, the men taking charge of the bridegroom and the girls of the bride, and decked in all their finery they are led to the bridal feast, and from that time the man becomes a member of the women's tribe.

Female chastity is not a very common virtue among the unmarried women and girls. It is not true, however, as has often been stated by travellers, that it does not exist at all. After marriage, however, the severest punishment always follows any unfaithfulness on the part of the woman—the guilty couple being put to death as soon as their crime is proved against them. I have never known a case of exchange of wives, as reported by Dr. Guppy and others, taking place in the Eastern part of the Group.

The birth customs of the New Georgian people are very peculiar. When the time of a woman draws near, she is considered ceremonially unclean. She is taken away to a little house in the bush, built by the women themselves —no man being allowed to touch it—there to await the birth of her child. No man is allowed to come near the place for at least fourteen days after the birth of the child. At the birth a sacrifice is made to the spirits, and blood sprinkled round and on the child, in order to propitiate the evil spirits, and incline them favourably towards the infant. Infant mortality is very great, and under the circumstances it is not to be wondered at. It is rather the result of carelessness, however, than the custom of

infanticide, which obtains in the Eastern part of the Solomons.

The burial customs, also, are interesting, as indicating some of the religious beliefs of these people. The body of a slave is usually buried in the sea, and no further notice taken. When one of their own people dies, however, it is a very different thing. If he is a man of any importance, such as a chief, all his people gather together, and a time of great feasting takes place. The body is decked out in all the finery and ornaments which he possessed, with shield and spear and axe, and fixed in a sitting posture it remains in the house for about three days. All the time great wailing and lamentation goes on in the belief that the spirit of the deceased will hear and be pleased. At the end of three days, the body is taken away, with great ceremony, and left on one of the small islands used as a burial place. After the flesh has left the bones, another big feast takes place, and with great ceremony the skull of the late chief is brought back and safely deposited in a little head house prepared for it at one of the sacred places near the village. To this place the friends go from time to time, taking offerings of food and ornaments, which they leave at the shrine, and make great lamentations in the belief that they are comforting the spirit of their departed friend. The period of mourning generally lasts for about eighty or one hundred days, and during the whole of that time the relatives of the deceased will not enter a canoe, or, in some instances, leave the house. They will not allow a drop of water to touch their bodies, nor a comb or knife to touch their heads. Their hair grows long, and is generally whitened with lime, and thus they live in filth and discomfort for months to express their sorrow. The head of a leper, or of a man who has met with a sudden violent death, by accident, they will not bring in for fear that they will meet with a like fate. On some of the islands in the group, the wives of important persons who die are expected to commit suicide, in order to accompany their lord and master on his last long journey. If they refuse, which they sometimes do, they are strangled by their friends, that the departed one may not be lonely. No one, of course, dies naturally in these islands. When a man dies his friends all believe that he must have been

bewitched. A witch hunt is organised by the sorcerors, and generally some unfortunate girl—very probably a slave—is taken, and is charged with witchcraft. If she confesses, which sometimes in sheer fright she does, the poor wretch is put to death at once. If she will not confess, she is hung up by the thumbs or wrists for several days at a time, until a confession is exorted from her, when death follows as a matter of course.

Concerning the buildings, canoes, weapons, food, etc., I have no time to speak in a paper like this. It would require a book to say all or nearly all about these things. I must, however, say a few words about the religious beliefs of these people. They believe in a Great and Good Spirit, whom they invest with the attributes of omnipotence and omniscience. This great Being is responsible for all things that exist. They believe that life is simply a road which at death is divided in two—the one leading to a place of happiness, and the other leading to "Sondo," the place of departed evil spirits. At the parting of the ways stands an old woman directing each to his place. They believe that the Great Spirit is not to be approached by mortals and hence they pray to the other spirits which control the destinies of man. To propitiate these they go to the sacred places and pray, and offer sacrifices—sometimes of human flesh, and sometimes of food, ornaments, and other things. Everything in the lives of these very superstitious people is connected in some way and controlled in some way by the spirits, hence the old sorcerers and witch doctors are people of great importance, and make a profitable thing out of the fears of the people. However, better days are dawning for the people of the Western Solomons. The power of the sorcerer is waning, and heading and witch hanging is ending, and, with a wise paternal government teaching the people agricultural pursuits and giving them something to employ their time, teaching them to work for themselves and thus better their condition, they would be a happy and contented people.

PAPER ON "CHILLAGOE GARNET ROCK."

By FRANK E. CONNAH.

Read before the Royal Society of Queensland, November 28th, 1908.

Introductory.—In all reports dealing with the geology of the Chillagoe District mention is made of the close association in the ore deposits of garnet rock with the copper minerals; in fact, Mr. Alexander Stewart, in his report for the Chillagoe Proprietary Company, in 1898, referred to it as being "one of the features of the field."

Occurrence.—Garnet rock occurs not only in the limestone country at Chillagoe itself, but also in other parts of the district, notably at Mount Garnet, where no limestone is found in the immediate vicinity. Instances have come under my notice of garnet rock being found in the outcrop of lodes which showed no signs of copper or other valuable metal, but very seldom is copper absent.

Garnet Mineral.—Garnet being a mineral of variable type, it is a matter of some interest to fix the type of the mineral of this district. So far as I am aware, the only analysis which has been published is one which was included, as being of interest, in the report of Mr. Stewart referred to. As I know that this analysis was made in a bush laboratory, under extremely adverse conditions, I have obtained a sample of the mineral from the same locality, and have submitted it to a careful analysis, the result of which I now lay before you.

Garnet Rock.—Before going further, I would remind you of the difference between garnet mineral and garnet rock, the latter term being applied to rock of which garnet mineral is a chief constituent.

Analysis of Garnet Mineral.—The analysis presented here is of the garnet mineral. The sample was obtained

from an outcrop near the Dorothy mine at Chillagoe, and consisted of a crystalline aggregate, the crystals being of yellowish brown colour, and consisting mostly of the usual rhombic dodecahedron. The crystals were carefully separated from cementing material (which, by the way, appeared to be amorphous garnet), and were obtained apparently clean. The analysis resulted as follows :—

Silica (SiO_2)	38.10%
Ferric Oxide (Fe_2O_3)	18.79%
Ferrous Oxide (FeO)	1.00%
Alumina (Al_2O_3)	9.75%
Manganese Oxide (MnO)	0.22%
Lime (CaO) (other than $CaCO_3$).. ..	31.06%
Magnesia (MgO)	Nil
Combined water	0.46%
Calcium Carbonate ($CaCO_3$)	0.57%
Moisture	0.12%
	100.07%

The carbonic acid (0.25%) was evidently due to admixed calcite which had escaped in the cleaning of the crystals, and it was therefore calculated to calcium carbonate.

The ferrous iron was determined by the hydrofluoric acid method. Triplicate assays gave identical results, and a check made on ferrous ammonium sulphate gave an accurate result.

The loss on ignition (0.8%) was higher than anticipated and pointed to the presence of combined water. As this was of interest, in view of the generally accepted theory that the formation of garnet took place under conditions of moist heat, I determined the combined water in $2\frac{1}{2}$ grammes, dried at 100° C., using series of calcium chloride tubes placed before and after the ignition tube; the result was a gain equal to 0.46%, which is reported as combined water.

The specific gravity was found to be 3.429.

Garnet Rock.—The garnet rock consists of garnet mineral, either by itself or, as is usually the case, mixed with one or more other minerals. It is a matter of some difficulty to say just what minerals are associated in the Chillagoe district, though it may be said that hand specimens usually show either calcite or amphibolite. When

copper minerals also occur above water level they either are secondary depositions in the accompanying mineral, or where the garnet itself has suffered decomposition, the copper is frequently heavily impregnated as oxide in the altered product. Below water level copper sulphide minerals frequently accompany the garnet, magnetic pyrites being often found. At the Dorothy Mine fluorspar is also found accompanying the garnet.

At Chillagoe the garnet-amphibolite combination is common, and was referred to as "eklogite" by Dr. R. L. Jack in his report on the field in 1891, and by Professor Skertchly in his report on the field in 1895, and again in his Presidential address to this Society in 1899.

At Mount Garnet the garnet mineral occurs mostly in an amorphous splintery form, closely admixed with calcite. It appears to form the walls of the enriched deposit at water level, being adjacent to a series of felsite dykes. An analysis of this rock resulted as follows :—

		For Comparison.	
		Mt. Garnet.	Chillagoe.
Silica (SiO_2)	28.2%	38.1	38.10
Ferric Oxide (Fe_2O_3) ..	15.9%	21.5	18.79
Ferrous Oxide (FeO) ..	0.4%	0.6	1.00
Alumina (Al_2O_3)	8.2%	11.1	9.75
Manganese Oxide (MnO) ..	0.3%	0.4	0.22
Lime (other than $CaCO_3$) ..	20.1%	27.2	31.06
Magnesia (MgO)	Nil	——	——
Combined Water	0.4%	98.9	98.92
Calcium Carbonate ($CaCO_3$)	25.5%		
Zinc Sulphide (ZnS) ..	0.6%		
Moisture	0.2%		
	99.8%		

It was impossible to obtain the garnet in this rock free from calcite, but the only minerals recognised were garnet, calcite and zinc blende. The second column above shows the figures for the garnet constituents reduced to the same basis as the figures in the Chillagoe analysis for

purpose of comparison. While only approximate they serve the purpose of showing this garnet to be of the same type as the Chillagoe crystalline variety, both being lime-iron-alumina garnet.

Alteration Products.—As is usual in copper deposits the lode rocks above water level show signs of intense action by mineral solutions. The garnet rock is to be found in all stages of alteration, the initial stages giving usually more or less magnetic products, and the final product being of friable nature and yellow to brown colour, having a characteristic appearance not easily mistaken.

LECTURE ON BRISBANE POND LIFE.

(SUMMARY OF LECTURE.)

By W. R. COLLEDGE.

Before the Royal Society of Queensland, November 28th, 1908.

THE lecturer, dealing with the subject generally, spoke upon the adaptation of the creatures to their environment, their great fertility, and the peculiar provision, by means of ephyppial eggs in the Entomostraca, for preserving and propagating their species in unfavourable weather. Fifty lantern slides made from local subjects were exhibited. These comprised:—Actinophrys eichornii, Vorticella, Epistylis, Desmids, Closterium Lunata and Striolata, micrasterias denticulata, Spirogyra, with specimens conjugating, Batrachospermum Moniliforme, Volvox globator, Conochilus volvox, a rare Rotifer *Brachionis Falcatus*, Limnia ceratophylli, Melicerta Ringens, Utricaria capsules enclosing larva of Ceratopogon, Tanipus, also Cyclops Quadricornis, Tubifex rivulorum, Nais, and Nais proboscidea in the act of dividing, Hydra Fusca, with slide showing its various organs, Cypris, Pulex Daphnia, and the hyaline form of carinata, Scapholeberis mucronata, Cyclops quadricornis, male and female, Cetochilis Australiensis, various larvæ of the caddis fly, using different materials to form their cases. The Water measurer, Hydrometra stagnorum, with parasite on thorax, Naucorides beetles, Notolecta Glauca, Ranatra linearis, Gyrinus Natator, Larva of the Dragon fly, the Ephemera, Coretha larva, and pupa, Hydropdilus. Afterwards some living specimens were placed in glass tanks before the powerful lens of the electric lantern; their magnification, and the manner in which various organs were seen, excited much interest as well as amusement, some of the larva much resembling prehistoric monsters.

THE LAND WE LIVE ON.

"Quid Faciat Lætas Segetes."—*Virgil.*

By J. C. BRÜNNICH, F.I.C.

Presidential Address read before the Royal Society of Queensland on January 29th, 1909.

So short and yet so comprehensive is the quotation from Virgil's immortal Georgic : " *What makes the crops rejoice ?* " that no better motto could be found for my address. dealing with the land we live on, the crops of this land. and the help which arts and sciences should and must give to agriculture, in order to utilise our inheritance of land to produce crops, which will rejoice both in quality and in quantity.

The subject of the address has been, on account of its importance. the favourite theme of many writers. The late Victorian Agricultural Chemist, Mr. A. N. Pearson, read a paper before the Australasian Association for the Advancement of Science in January. 1900. on "*The Scientific Directing of a Country's Agriculture,*" in which he chiefly directed attention to the great advantage of manuring and improved tillage in order to obtain heavier crops, and drew attention to the necessity of soil survey, establishment of experimental farms. and the systematic examination of products.

My friend, Mr. F. B. Guthrie, the Chemist of the New South Wales Department of Agriculture, delivered in 1906 a lecture on "*The Application of Science and Scientific Methods to Agriculture,*" under the auspices of the Sydney University Extension Board, in which he gave a short historical review of the evolution of scientific agriculture, and the recent results achieved by the aids of science. Mr. H. W. Potts, the Principal of the Hawkesbury Agricultural College, in his address on "*The Outlook for Agriculture,*"

etc., recently delivered as President of the section for agriculture of the Australasian Association for the Advancement of Science held in Brisbane, largely touched on the same question.

Still the question is such an important one that it cannot be brought too often before the public and before our legislators, particularly if we bear in mind how much still remains to be accomplished. Although agriculture has made great strides during the last 50 years, and particularly of late, some startling and far-reaching discoveries have been made, yet the Secretary of the United States Department of Agriculture stated, quite recently, that farming is still in its infancy, and that the present productivity of farms is merely a forerunner of the marvellous results which will be obtained in the future.

If there is any country in the world which strives to do justice to the scientific advance of agriculture, it is undoubtedly the United States of America, with its numerous Agricultural Colleges, Experimental Farms, with large staffs of scientists spread all over the States, and at their head the Bureau of Agriculture, with eminent men guiding and controlling the whole. If agriculture is only in its infancy there, how does agriculture stand in Australia ? Is it born at all ?

I myself have been connected with the Queensland Department of Agriculture and Stock for some considerable time, and must openly confess that agriculture in general has not made the progress it ought to have made, although a few branches, dairying for instance, have advanced considerably. But apparent progress is only too apt to make us satisfied and forget that it might have been possible to do very much better. I cannot do better than quote some of the remarks made by Mr. J. M. Hunter, M.L.A., who recently visited South Australia, and made some of his impressions public in the *Brisbane Courier* (*Nov.* 17, 1908) :—" I do not regard it as part of my duty at this juncture to blame or explain the acts of administration, or the want of them, that is responsible for the state of agriculture in Queensland to-day. I content myself by stating an unpleasant but pertinent fact, which is that while in the South and South-west of Queensland we possess a territory unequalled in any State of the Common-

wealth for size, quality of soil, and rainfall, we are not growing one quarter of the food-stuff we consume, while in South Australia they not only feed themselves, but after contributing largely to the needs of the Commonwealth, they sent away to oversea markets last year over £2,500,000 worth of wheat and flour."

An advancement of our agriculture can only be brought about by encouraging close settlement in agricultural districts; by affording financial support to the farmers in their earliest struggles, by teaching the farmers the latest methods by practical demonstrations on Experimental Farms, and in Agricultural Colleges by establishing research scholarships at these institutions, and finally by introducing agricultural subjects into our elementary schools, so as to inculcate into the mind of our children a love for the noblest of all trades: "*To dress the earth and keep the flocks of it—the first task of man and the final one.*"

The carrying out of this policy is largely one of expense, and it is a very bad sign, and shows great shortsightedness, that our legislators during bad times, necessitating retrenchments, put the pruning knife into the Department of Agriculture. In times of drought, our proverbial lean years, so far from retrenchment being set in motion, a young country should increase its expenditure, even at the cost of borrowing, just as the gardener waters his plants in dry weather to ensure future bloom. Such expenditure means **Prosperity to Posterity.** Nations are immortal, individuals are only mortal. I will give an instance of the fallacy of the present policy: A former principal of our Agricultural College was severely criticised for purchasing machinery and implements for the institution which were found to be of little or no value, and had to be replaced by other ones. Is it not much wiser that such implements should be tried once for all at a college, in order to let students see the advantages and disadvantages of each, than that useless or inefficient implements should be purchased by farmers, who have nobody to guide and advise, and have to rely upon the glowing testimonials displayed by the agents; testimonials which perhaps are genuine enough, but not applicable to local conditions?

But why this singling out of **Agriculture,** for discussion; wherein lies its importance?

Of all the primeval instincts **hunger**—the craving for food—is the most powerful and far-reaching one, and the supply of the necessary food to mankind is the principal object of agriculture. Nothing perhaps emphasises this necessity better than the humble prayer of every Christian: "*Give us this day our daily bread.*" We do not ask for clothes, or habitation, or other needs of life, but beg for bread only.

How beautifully Ruskin, in his immortal work "*Unto This Last*," shows us the importance of agriculture and the intimate connection of it with the wealth and welfare of a nation:—

"So long as men live by bread, the far away valleys must laugh as they are covered with the Gold of GOD."

"The wealth of a nation is only to be estimated by what it consumes."

"There is no wealth but Life, Life including all its powers of love, of joy, and of admiration. That country is the richest which nourishes the greatest number of noble and happy beings," and finally,

"There are two kinds of true production always going on in an active State: one of seed, and one of food; or production for the ground, and for the mouth."

The great importance of the **food supply of the world** was the leading feature of the epoch-making lecture delivered by Sir William Crookes ten years ago, at Bristol, in his inaugural address as President of the British Association for the Advancement of Science, in which he clearly showed that the world's consumption of wheat is rapidly overtaking the supply.

Professor Sylvanus P. Thompson, again, declared about two years ago that a shortage of the wheat supply is already imminent, and that in 1910 the demand will be barely covered by the production.

Sir William Crookes' lecture is particularly interesting to us, as Queensland is specially mentioned in the address, and the extracts of a few of the data will be of value. The world's wheat crop for 1897-8 was about 2,000 million bushels, to which Australia, with its very vast areas, only contributes 33 million bushels, or about $1\frac{3}{4}\%$; the United States produced 510 million bushels or 27%, and the two countries Italy and Spain together 178 million bushels

or nearly 10%, corresponding to the annual import of wheat into the United Kingdom. I specially mention these two countries, as their climate somewhat resembles our own. The two States together are about one-half the area of Queensland, but whereas Queensland has only in all 600,000 acres or about .14% of its total area under crop, the land cultivated in Italy and Spain amounts to 47 and 39% respectively, which accounts for the large production of cereals.

Professor E. M. Shelton made years ago a rough estimate of our lands suitable for wheat culture, and considered about 50 million acres were fit for the cultivation of wheat. At present our area under wheat amounts to only 150,000 acres. The great drawbacks to wheat culture in Australia are the climatic vicissitudes, as is clearly shown by the variation in the annual average yield. In Queensland the average yield for twenty years is 14.7 bushels per acre, which in the drought year 1902 dropped to 3.3 bushels, whereas the crops of last year will go well over the average. Victoria shows similar fluctuation, two years ago the crop was only 6.6 bushels, whereas last year (1908-9) an area of 1,885,000 acres yielded 12.8 bushels per acre. But, in spite of dry weather, good crops of wheat may be grown by improved methods of cultivation and the selection of healthy rust-resisting varieties. In 1907, on the Roma State Farm, a crop of 14 bushels per acre was obtained with only 3¾ inches of rain between seed time and harvesting. Last year the crops were very much heavier, averaging well over 20 bushels per acre, but several varieties of wheat yielded up to 38 bushels.

The United Kingdom with an average yield of 29.5 bushels is only able to grow 25% of its required wheat and has to import 75% from abroad, and rarely holds more than 14 weeks of supply on hand. What help it would be not only to us, but also to the Mother country, if we could cultivate part of our 50 million acres and supply Great Britain's demand of 180 million bushels.

Agriculture is the most ancient of all arts, coeval with the first dawn of civilisation. Agriculture flourished in ancient Egypt and Mesopotamia. The ancient Romans highly esteemed husbandry, and spread the knowledge of agriculture all over Europe. In the early times the Anglo-

Saxon races much neglected agriculture, which indeed could not flourish under the feudal system. In the middle ages the best land belonged to the church, and the monks not only carefully cultivated their lands themselves, but supervised the cultivation of such lands which were leased to farmers.

The development of agriculture in England may be traced from some of the old writings on agricultural subjects. One of the earliest works is the "*Books of Husbandry*," written in 1539, by Sir Anthony Fitzherbert, followed by Tusser's "*Five Hundred Points of Good Husbandry*," and Googe's "*Whole Art of Husbandry*." Of particular note was the work of Sir Richard Weston, published in 1645, "*Discourse on the Husbandry of Brabant and Flanders*," which largely induced the introduction of some of the methods of the justly-celebrated Flemish agriculture into England. A very marked influence was also affected by Jethro Tull's "*Horse-Hoeing Husbandry*," which appeared in 1731.

The value of the application of **Chemistry** to agriculture was very soon recognised, and already in 1795 the Earl of Dundonald, an ancestor of our late Governor Lord Lamington, published a treatise showing the intimate connection which existed between agriculture and chemistry. Unfortunately, the work did not receive the attention from the farmers of Great Britain and Ireland which it actually deserved. A much greater practical effect followed a series of lectures delivered by Sir Humphry Davy in 1812 before the Board of Agriculture. The greatest advance in agricultural Chemistry was, however, due to the efforts of Dr. Justus von Liebig, whose first complete work was published in 1840. By the help of his teachings many operations and methods of cultivation carried out instinctively by farmers, methods transmitted from father to son, or accidentally discovered, were explained by scientific reasoning, and thus rendered more eminently and consistently useful. The work of Liebig was eagerly taken up, and used as a foundation for the scientific building up of agriculture by men like Anderson, Berzelius, Bousingault, Johnston, Voelker, Wolff, and carried on at the present day by Hall, Mitcherlich, Schloesing, Wiley, and many others.

The foundation of all agriculture is unquestionably the **Soil,** a layer of more or less weathered, crumbled rock, which covers the surface of Mother Earth, and is absolutely necessary to support any growth of plants. Only by the aid of the mineral matters obtained from the soil are plants able to grow and assimilate the organic plantfoods existing as an inexhaustable supply in the ocean of air. The constitution of the soil is very intricate and ever changing, and both the mineral ingredients, and the organic substances, **Humus,** formed by the decay of vegetable matter, together with the host of micro-organisms living in the soil, are of vital importance.

The importance of bacterial life has only of late years been properly recognised, and when we are told that one grain of soil may contain millions of micro-organisms, one cannot wonder at their far-reaching influence on the fertility of a soil.

The skeleton of the soil is formed by mineral matters, and **Geology** is the science which will teach the agriculturalist the influence and importance of certain rocks on the composition of soils. Geological maps of countries, illustrating the underlying strata, are of immense value to the scientific farmer, particularly those known as drift maps, which show the mineral matters actually existing on the surface. In some countries accurate soil maps are now available, which indicate the class of soil in each locality. These can only be produced by an exhaustive special examination. The United States Bureau of Agriculture has undertaken such a complete soil survey, a truly gigantic undertaking which will employ a large staff of experts for years.

But for the study of the soil, other factors besides geology have to be taken into consideration; they are its chemistry, physics, and, as already indicated, its biology, all which go hand in hand for the elucidation of the character of a soil. For years the fertility of a soil was chiefly judged by its chemical composition, paying, of course, due regard to the mechanical and physical condition, but of recent years the American school, as represented by M. Whitney and F. K. Cameron, declare that the chemical composition of a soil has little to do with or to tell about the fertility of a soil, and that manures, if they

have any effect of increasing the crops, do so by altering the physical texture of the soil.

But other investigators, like R. D. Hall, the present director of the celebrated Rothamstead Experimental Station, clearly demonstrate from numerous and continuous manuring experiments that the views of the American scientists cannot be considered as generally applicable. A good many factors unquestionably combine to produce fertility, and the **duty of every farmer** is to **maintain,** and if possible **increase,** the **fertility of the soil,** so as to get maximum crops from his ground.

Not only the actual amounts of available mineral matters in the soil are of importance, but also the proportion between them, and it has been shown quite recently by Japanese scientists, Loew, Aso, Daikuhara, and others, who have done a large amount of experimental work, that the ratio of Lime and Magnesia are of particular importance.

Whitney's theory that soil becomes unfertile by the accumulation of toxic substances excreted by the roots of crops, and that the fertilizer act, not as a direct plantfood, but by destroying these substances and putting them out of action, has been supported by the results of investigations carried out in India. F. Fletcher proved by field experiments that there is an actual excretion of alkaloidic substances by the roots of plants, which are toxic both to the parent plant and to other species. The sensitiveness of crops to the excreted toxins varies considerably. The results are of great importance with regard to the rotation of crops, and explain the advantages of certain rotations, showing for example why cotton grows feebly near sorghum, yet thrives at least as well, if not better, after sorghum than after cotton.

Each crop fouls the soil for a succession of the same variety. The toxic substances can be precipitated by mineral manures, and also by certain vegetable refuse (leaves, etc.) containing tannic acid. Even before Fletcher published the results of his investigations several African Chemists showed that the sterility of certain soils was caused by the presence of toxic organic substances, the effects of which could be corrected by the use of stable manure, green manure, leaves of sumach, oak, etc., tannic acid and

pyrogallol, calcium carbonate, ferric hydrate and carbon black.

Experiments on these lines would be of particular value in our State to such crops as sugar cane, pine apples, which are continuously grown on the same soil for years.

On the whole, soil chemistry has shown that exceedingly small amounts of mineral matters dissolved in the water within the soil are necessary for plant life, aided perhaps to some extent by a direct solving action of the roots upon the solid mineral matters. This theory had its foundation in the classical experiments of Sachs (1860) in which plant-roots were allowed to attack a slab of marble. Many investigators adhered to the notion that the rootlets excrete acids which help in the solution of the mineral matters, and on this theory the determination of **available plantfoods** in a soil by treatment with dilute watery solution of citric acid, as originally proposed by Dr. B. Dyer, in 1894, is based. The excretion of acids is, however, not necessary to account for the solvent action of roots, as is proved by the fact that soils maintain their neutral reaction under cultivation, although continually removing small amounts of bases from the soil. Instead of the acidity increasing under cultivation the watery soil solutions tend to get more alkaline. The slow solvent action of water on the soil particles is materially aided by the ever-present carbonic acid, given off continually by the growing roots, and indeed the determination of the available mineral plantfoods in a soil by one of the most recent methods, consists in treatment with water charged with Carbonic acid gas.

One of the most wonderful aspects of nature is its dealing on the one hand with infinitely large quantities and distances quite beyond the range of human conception, and on the other hand with infinitesimal minute quantities, while still holding a true balance between all.

We know that **Carbon** is the principal constituent of all organic tissue, and that plants obtain all their carbon from the minute quantities found in the atmosphere. The air contains approximately about three parts of carbonic acid in 10,000 parts, or in a cubic yard of air, weighing a little over 2 pounds (2.28lbs.) we find only 7 grains of Carbonic acid. The amount of carbonic acid varies with the altitude, and at a height of 18 miles, according to

Hinrichs, all carbonic acid has disappeared. Boussingault was the first to prove conclusively that the carbonic acid in the air is used for the assimilation of carbon by plants, and that other sources of carbonic acid, as from soil and water, are of little consequence.

A crop of wheat will remove one ton of carbon from an acre of ground in four months, or as much as is contained in a column of air 3 miles in height, and a crop of maize removes in the same time about three times as much.

Now the actual work done by the sun in the plant tissue to produce this assimilation amounts to at least 3,000 horse power per day per acre, corresponding to the work of 15,000 men. We can now understand what an enormous amount of energy is wasted and lost for every acre we leave even partially uncultivated. George Ville, in lectures delivered in 1883 at the Academy of Brussels, puts this case very clearly. These lectures were translated and edited by Sir William Crookes under the title "*The Perplexed Farmer*," and they should be read by every one interested in agriculture.

Another essential constituent of plant food is **Nitrogen,** one of the most inert of elements, in this respect approaching to the argon group. Although an inexhaustible supply exists in the atmosphere, 4-5ths being pure nitrogen, the higher plants cannot use it directly. It would be almost true to assert that the whole question of successful agriculture centres about the fixiation of nitrogen. This essential of life is largely supplied to plants in the form of that "*villainous saltpetre*" which, as gunpowder, we use for the destruction of life. Nitrogen, indeed, performs so important a role that one might almost christen agriculture "**Azotism.**" Yet, I would remind you the very word **Azote,** still used in France, was given to it for the very reason that, *per se*, it is incapable of supporting life—so involved are the processes of Dame Nature.

Only some few of the micro-organisms are able to assimilate atmospheric nitrogen directly; all higher plants must get their nitrogen in form of nitrates, and the principal source of this combined nitrogen is the small amount produced when organic substances are burned in air, and by the direct union of oxygen and nitrogen in the air under the influence of electric discharges. The extremely minute

amounts of ammonia salts nitrates and nitrates in the air are collected by the rain. The amount of rainwater in nitrogen has for years been carefully ascertained at Rothamstead, and it was found that the average rainfall of 29 inches supplies yearly 3.84lbs. of nitrogen per acre, although the rainwater itself contains in an average only 4-10ths part of nitrogen per million in the form of ammonia, and 1-10th part per million as nitrate nitrogen. Similar determinations were carried out elsewhere, and the prevalent idea that the amount of nitrogen in the water of tropical countries is much higher has not been sustained by the records published by Leather for the rainfall collected in India, at Dehra Dun and Cawnpore. They give almost identical amounts of nitrogen obtained in England, namely, 3.25 and 3.4lbs. per acre, although the rainfall was 86 and 49 inches per annum. Ingle made similar experiments in Pretoria, and found that a rainfall of 24 inches supplied 6.58lbs. of nitrogen per acre as ammonia, and 1.08lbs. as nitrate nitrogen. I arranged for collection of rainwater at our Roma State Farm, at the tropical Experimental Station at Kamerunga, near Cairns, and at Brisbane, for the past year, and the results so far seem to indicate that our rain is not very rich in nitrogen compounds.

One of the principal objects of agricultural chemistry is to teach the farmer how he can best maintain the **fertility** of his soil. Fertility can only be maintained by giving back to the ground that which the crops themselves take away, and this is easily done by the application of **artificial fertilizers** supplying the essential plantfoods: **nitrogen, potash,** and **phosphoric acid.**

A continual process of gain and loss of all the plantfoods, more particularly of nitrogen, is taking place in every soil, and it is one of the main objects of the agriculturist to encourage every increase of nitrogen, and at the same time reduce its waste to a minimum. A crop of wheat removes from the soil, in the grain alone, from 30 to 50lbs. of nitrogen per acre. Of all the fertilizing constituents, nitrogen, although so abundant in the air, is the most expensive to obtain, and consequently one of the great aims of experimental chemistry has been to devise a means of utilizing the atmospheric nitrogen.

An increase of nitrogen in soil is derived, as already mentioned, from the small amounts of nitrogen compounds dissolved in the rain water.

As shown by the now historical researches of Hellriegal, leguminous plants make direct use of the atmospheric nitrogen by the aid of micro-organisms, living in the root nodules, and green-manuring, with leguminous crops, can therefore to some extent supersede the direct application of nitrogenous manures. Bacterial cultures under the name of "Nitragin," to be added to the soil or for the direct treatment of the seed itself, to encourage the activity of the nitro-bacteria, were prepared by Nobbe, of Tharand, and Hiltner, in 1896, but did not prove a great success. Such cultures have been improved by G. Moore, of the U.S. Department of Agriculture.

Another gain of nitrogen is finally obtained by the action of bacteria and micro-organisms living free in the soil, which are capable of assimilating atmospheric nitrogen. Winogradsky has already years ago proved such assimilation of nitrogen by certain forms of *Clostridium*; Beijerinck, Heinze, and others, by certain blue-green algae, *Cyanophyceae*.

Of more recent date are the investigations of Krüger, Schneidewind, Mazé, Gerloch, Vogel, Heinze, and others, proving fixation of atmospheric nitrogen by so-called Azoto-bacteria. The presence of these bacterial forms was detected in the soils of cultivated fields and of meadows, in sand of dunes, and also in seawater. Azoto-bacteria require for their growth not only certain amounts of easily available mineral substances, chiefly phosphoric acid and potash salts, but also organic compounds for the supply of carbon, as these low forms of life cannot assimilate carbonic acid. These compounds are furnished by the higher plants, and by the decay of vegetable matters. The bacteria further require suitable temperature, mositure, and finally, plenty of air, so that they thrive best in loose, moist, deeply cultivated soil.

The farmer has it, therefore, in his own hands to improve the nitrogen contents of his land by encouraging the growth of these organisms by thorough cultivation.

Dr. R. Greig-Smith, the Macleay Bacteriologist of the Linnean Society of New South Wales, in his studies

of slime producing bacteria, proved the fixation of atmospheric nitrogen by Azotobacter, and summarised the work of such friendly bacteria (proceedings of the Linnean Society of N.S.W., vol. XXXI., p. 615), by stating: "We are now certain of the kind of help which the bacterium gives the plants. There exists a symbiosis; the plant supplies saline and saccharine matters, the latter of which the bacterium converts into gum, and at the same time elaborates atmospheric nitrogen into constituents which are partly contained within the bacterial cell, and partly diffused in the gum, which by virtue of their presence, appears as a slime. Both the nitrogenous and the carbohydrate constituents of the slime are then elaborated by the plant-cells into tissue elements."

A further supply of nitrogen in the form of artificial fertilizer is frequently absolutely necessary, and hitherto farmers of the whole world have been depending largely on the supply of saltpetre fields of Chili. With an annual output amounting to 1,740,000 tons in 1907, a depletion of these mines is expected within 50 years, and the necessity of some other source of nitrogen becomes very apparent

Birkeland and Eyre are now producing nitrates from the atmospheric air at their factory at Nottoden, Norway, by electric discharges, thus reproducing one of Nature's processes. An enormous supply of water produces the cheap electric power necessary for heating the special electric furnaces through which air is passed, and the nitric acid obtained by the direct combination of nitrogen and oxygen is absorbed by milk of lime, to form **calcium nitrate.**

Another new nitrogenous manure is the **calcium cyanamide,** produced by the action of atmospheric nitrogen on calcium carbide, the well-known compound used for the production of acetylene gas, or on a mixture of lime and charcoal, heated to 2000 degrees C. The product Cyanamide, or *Kalkstickstoff*, contains from 14 to 22% of nitrogen, which is given off in form of ammonia, when water acts on the substance in the ground. Experiments carried out with the fertilizer seem to give excellent results.

Another very important line of investigation in agricultural chemistry and physiological chemistry is the study

of **animal nutrition,** and the **composition of foddercrops,** and **food-stuffs** in general. A large amount of experimental work has been done in this respect in Europe and in the United States, yet many esssential points are still shrouded in mystery. Wolff was the first to publish a special work on "*farm foods*," in 1864, chiefly based on the researches of von Voit, and Pettenkofer, carried out at Munich, and his own work at the Agricultural College at Hohenheim.

In the analysis of fodders very little progress has been made, and the original "Wende" method, introduced by Henneberg in 1864, is still largely used, although the results can be hardly called satisfactory.

Of particular importance are the analyses of our staple foods, **wheat** and **wheaten flour.** As most of the wheat is used in the form of flour, the milling and bread-making qualities are of chief value. With the introduction of improved methods of milling, many of our old popular ideas have been exploded, and the notion that dark-looking and whole-meal bread are more nutritious than white bread is proved to be a fallacy. Our modern millers produce not only a whiter but a more nutritious and more easily digested flour than their predecessors. Professor Snyder, of the University of Minnesota, has clearly shown that from nearly every class of wheat the white flour of commerce yielded more nutriment than the whole-meal, and that the addition of bran made flour more indigestible. The value of flour is practically judged by bakers by its **strength,** or the capacity to produce a bold, large-volumed, and well-risen loaf. We do not know yet what really constitutes the strength of flour, or how many factors take part in its production. Quantity, composition and character of the insoluble proteins—Gluten—of the flour are some of the principal factors, but others are of equal importance, and the new fact made known by A. D. Hall that, although individual flours may be of poor strength and produce poor loaves, a blending of such flour nevertheless produced an excellent loaf; but only a mixture of the flours in certain proportions gave results equal to a sample of strong Manitoba flour. Again, it was shown that the strength varied if the wheats were harvested half ripe or dead ripe. These investigations prove the practical

value of the methods in practice by all millers to blend their wheats, and also shows that the results of milling and anaylses alone are not at all sufficient by which to judge the value of any wheat. As a matter of fact, experimental milling should be carried out on a far larger scale, and a few bags of each of the flours produced, so as to enable different blends to be made and bread from the separate and blended flours to be tested.

A further important research is the detection of **injurious** and **poisonous compounds** in fodder plants, and with regard to this an enormous amount of work will have to be done in Australia. Of particular interest has been the discovery of a hydrocyanic acid-yielding glucoside in the fodders belonging to the Sorghum family. Already, in 1803, Schrader had proved the toxic principle of bitter almonds to be hydrocyanic acid, since when investigators have shown the presence of free prussic acid and of cyanogenetic glucosides in many seeds and plants. Most likely they play an important rôle in the synthesis of the Proteins. Treub asserts that these bodies are the first recognisable product of the assimilation of the nitrogen of nitrates by plants. How the hydrocyanic acid itself is first formed is still a mystery, although Gautier's suggestion that it may be formed by a reduction of nitrates by formaldehyde is a very feasible one.

I cannot leave the application of chemistry to agriculture without mentioning the great value which chemical methods of analysis have been in the develoment of the **dairying industry.** The introduction of simple methods for the determination of fat in milk and cream has put the industry on a sound scientific basis.

I shall now pass on to the consideration of some of the other sciences influencing the development of agriculture, and of necessity can only give bare outlines in some cases.

Botany has always been of recognised importance in the search for new plants suitable for food, or of other commercial value. But perhaps one of the chief functions of the application of this science is the improvement of plants by breeding and cross-fertilization.

As early as the beginning of last century Lamarck revolted against the dogma of the immutability of species.

By Darwin's work—"considered a decidedly dangerous book to old ladies of both sexes"—the mystery of hereditary was somewhat cleared up by experiments in cross fertilization. The improvement of cereal grain, more particularly of wheat by hybridising, is a matter of utmost importance, and a good deal of work has been done already in this direction. A large number of hybrids of wheats have been raised at the Minnesota Experiment Station, and in New South Wales the late Mr. W. Farrer produced a large number of cross-bred wheats, some of which proved of considerable value. Similar work with regard to fruits in particular has been done by others.

Still the matter of breeding lacked a thorough scientific basis, and the work was, as stated by Lindley half a century ago, "a game of chance played between man and plant," which, as a matter of fact, was always largely in favour of the plants.

The mystery has been solved by the exceedingly valuable work of a monk, Gregor Mendel, of the Abbey of Brünn, in Austria, who, as the result of eight years' painstaking experiments, communicated to the Brünn Natural History Society a paper on "*Experiments in Plant Hybridisation.*" This work was completely overlooked, and lay for 35 years in the archives of the Society, only to be re-discovered in 1901, almost simultaneously by three scientists, de Vries, Correns, and Tschermak. It was shown that the work of the amateur botanist gave a clear and complete theory with regard to the working of heredity, and based on his researches and theories cross-fertilization reaches almost the accuracy of mathematical science. Briefly his theory is, that inheritance consists in the transmission of independent characters—the *Constant Characters*—of which each species possesses a certain definite number. These characters form pairs of opposites or alternatives. The characters are distributed among the germ cells in systematic manner, so that no germ cell will carry both numbers of a pair. Biffen, of the Agricultural Department of the Cambridge University, has taken the work up, and has already obtained very interesting results in the cross-fertilization of wheats and barleys.

Botany is also of importance in the study of many **plant diseases.** Smut and rust are very prevalent diseases

caused by fungi. The infection frequently takes place in the seedling stage, and the germs of the disease may also be lying dormant in the seed itself. In the case of wheat and barley, the seedling is not attacked by the smut spores, but during the flowering stage attacks the plants, settling on the ripening grain. Fungicides, rotation of crops, obtaining seed from healthy crops, and the breeding of disease-resisting varieties are the principal remedies.

Perhaps no science has made such great progress, and has been of such far-reaching influence in every-day life as **Bacteriology.** The influence of bacteria on agriculture is of utmost importance. We have already mentioned that by the aid of bacteria leguminous plants may directly assimilate nitrogen from the air. In nearly all cases reaction and changes going on continually in soil micro-organisms are the principal factors. The change of the nitrogenous matters into ammonia compounds, and finally into nitrates, generally called the process of *nitrification*, is caused by certain bacteria. A reversal of the process-*denitrification*—by which from nitrates and ammonia salts free nitrogen is liberated, and thereby lost—is likewise caused by bacteria. **Soil Biology** is quite a science of its own, and some observers attribute the assimilation of all inorganic and organic plantfoods, by the roots from the soil, to the action and help of bacteria. Bacteriology is of equal importance to dairying; the ripening of cream and cheese are both caused by bacteria, and so are souring of milk, development of bad flavours in butter and cheese. Desired results can only be obtained by thorough sterilisation of milk and cream, and the subsequent use of pure cultures of certain bacteria as starters.

The great and principal objects of sciences of **Engineering and Mechanics** are to harness the forces of Nature to the service of agriculture, and to improve the various implements and machines used in its various branches. These sciences are of further importance in the carrying out of schemes of water conservation, and in the preparing and laying out of land for draining and irrigation. This branch of engineering is of particular value to our State, and just at present, when the Government are anxious to carry out such schemes, the want of

trained men is acutely felt. Engineering is of further great importance in the dairying industry for the construction of milking machines, separators, pasteurisers, churns, butter workers, refrigerating machines, etc.

With reference to implements, let me give a short history of the **Plough**, one of the most necessary implements of a farm, used for the breaking up and turning over of the soil, to replace the slow and laborious hand digging. The use of the plough dates back almost to the earliest history of mankind, but the implements used in early times were, as a rule, primitive and clumsy, chiefly constructed of wood. Ploughing with shares shod with iron and bronze is mentioned in the Old Testament. Ploughs with wheels were also used by the ancient Greeks, but none of the old ploughs actually turned over a furrow. The modern plough, with a mould-board to turn over the soil, seems to have been invented in the Netherlands in the 17th century. Up to the middle of the 19th century the mould-boards were generally made of wood. Since that time great improvements in the construction of ploughs have been made, and different types are used for specific purposes. A particularly great advance was the introduction of the American Gang and Sulky plough, and the newest type of disc plough, so admirably suited for many of our classes of soil. In other implements, such as harrows, rollers, cultivators, etc., the ingenuity of the mechanic has made many improvements. As early as the year 1858, in an article in the *Journal of Agriculture*, the necessity of the application of **steam ploughs** to agriculture was strongly advocated in Great Britain. Paradoxical as it seems, Ruskin in his idealistic social democracy emphatically condemns the employment of steam in agriculture. In the year 1618 patents for engines to plough the ground without horses or oxen were taken out by David Ramsay and Thomas Wildgoose, followed by other patents for the depositing of seeds and manures, which, however, the wags of that time considered regular "wild-goose schemes."

Towards the close of the 17th century, Francis Moore took out patents for a machine to go without horses, to be applicable to ploughing and harrowing, and to all branches of husbandry. So sanguine was he of his results

that he sold all his horses, and induced many of his friends to do likewise. His work was improved upon by Richard L. Edgeworth, who took out patents in 1770. Since that time numerous other patents have been taken out, all of which helped to perfect the modern steam plough. I can only mention the names of Major Pratt, Heathcote, Alex. McRae, John Tulloch, Osborn, Boydell, H. Hannam, James Usher, Hoskyns, Williams, and Fisken, who, during the middle of the 19th century, patented various schemes for steam cultivation, which are the fore-runners of the system of John Fowler, the principal system used at the present day.

For harvesting, machines were also found a necessity as labour-savers, and as early as 1829 a **reaping machine** was invented by the Rev. Mr. Bell, of Carmylie, Forfarshire, whose struggles in this regards are almost pathetic. For trials he had to plant stalks of straw one by one in sand in his back yard, in order to find out how his machine would cut the straw. His machine, in an improved form, is still in use. Mowing and reaping machines have now been greatly improved, and not only cut the crops, but bind the straw up into sheaves. Cyrus McCormick is the inventor of the most modern reaping machine. One of his first machines, shown in the Crystal Palace Exhibition in 1851, was called by the *Times* "a cross between an Astley chariot, a wheel barrow and a flying machine," but afterwards was considered worth the whole of the exhibition.

At the present day one of our chief wants is a good cane-cutting machine, and it is interesting to note, just now, that here in Brisbane an engineer has patented and constructed such a machine, which will soon make its first practical trial, and which from appearance seems to have solved the problem, and if so will be of enormous value to the sugar industry.

Other machines in which the ingenuity of the mechanic and engineer has been exercised are implements for sowing of seed, distribution of fertilizers, planting and harvesting of tubers, etc., and finally implements to improve cultivation, so as to **conserve the soil moisture** as much as possible.

A good deal remains to be done in the invention of machines directly utilising the light and heat of the sun

as a motive power, to take the place of the expensive steam power. Wind and water power are already largely utilised. The production of a cheap alcohol has made enormous progress on the Continent, and no doubt the time will come when we shall utilise some part of our crops, and more particularly the millions of gallons of Molasses, the bye-product of our sugar mills, which now almost entirely go to waste, to be manufactured into alcohol, a liquid fuel which can completely replace petroleum and petroleum spirit, imported in large quantities from America, for the driving of motor cars, launches, farm engines, and also for lighting and cooking.

Electricity itself is now used as a direct aid as a plant producer. I can only mention the Thwaite system of Electro-culture, a system using direct light and heat produced by powerful arc-lamps to plants, to stimulate their growth. Sir Oliver Lodge's large-scale experiments of electro-culture, by passing electric currents through wires and cross wires stretched across the fields on poles, are giving according to recent reports up to 40% increase in the yield of grain. Professor Lemstrom's experiments to apply electric currents to cultivated fields, and the French system of utilising atmospheric electricity for agriculture, and the direct treatment of seeds with electricity are further attempts in this direction.

Veterinary science will help in the breeding of stock, in the treatment of diseases, and in this respect a good deal of work has to be done in our State, chiefly in the investigation of Redwater and other diseases.

The **Entomologist** and **Vegetable Pathologist** have to investigate insect pests, plant diseases, and find remedies for all, particularly to seek the most successful and practical methods of combating insect pests by the introduction of parasites, requires careful and painstaking labour and research. One of our great problems is the destruction of noxious weeds, lantana and prickly pear ; for the former a natural check by insects has already been found in Hawaii, and whether it is possible to find a similar remedy for the prickly pear will be seen in the future.

There are other sciences which have a more or less direct bearing on agriculture, but time permits me to mention only one more, and that is **Education.** Consider-

ing the importance of agriculture it is always to be wondered at how completely agricultural education has been neglected for years, and how farmers have been left to shift for themselves and battle with adverse circumstances. How to educate the farmer has always been a question open to different views and serious discussions. It has of late years been seriously taken up and the teaching of the elements of agricultural sciences have been even introduced, as it should be, in the lower schools.

The first Chair of Agriculture in the University of Edinburgh was instituted by Sir William Pulteney, in 1791, with Dr. Coventry as its first professor. An agricultural College was founded in Cirencester in 1839, which is still in a very flourishing condition. In Ireland, an agricultural school was established in 1821, which was followed by the establishment of agricultural training schools, and the introduction of the teaching of agriculture in the national schools, which has proved a very successful and economic system.

Of great educational value are the numerous agricultural societies existing everywhere. As early as 1723, a "*Society for the improvement in the knowledge of Agriculture,*" was established in Scotland, followed by a similar Society in Dublin in 1737. The "*Bath and West of England Society*" was founded in 1777, the "*Highland Society*" in 1784, the "*Board of Agriculture*" was formed in 1793, and controlled by Sir John Sinclair, and the "*Royal Society for the improvement of Agriculture*" was established in 1847.

At the present day we must consider the United States of America to stand at the top of all countries with regard to agricultural education, their system of Agricultural Colleges, Experiment Stations, Agricultural Universities, and the teaching of agriculture in lower schools is well nigh perfect, no labour or expense appears to be spared.

Let us hope that our country will soon be in a position to spend a proportionate amount of money for the development of agriculture, just as it is done elsewhere. We must never forget that farming is not only the most difficult of professions, but the only profession which is absolutely indispensable to mankind. For this reason agriculture

should be recruited from the most intelligent and persevering of workers.

In "*Time and Tide*" Ruskin says :—

"A labourer serves his country with his spade just as a man in the middle ranks of life serves it with sword, pen or lancet," and finally "Now the fulfilment of all human liberty is the peaceful inheritance of the earth, with its herb yielding seed, and fruit tree yielding fruit after his kind, the pasture, or arable land, and the blossoming or wooded and fruited land uniting the final elements of life and peace, for body and soul."

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THE CLIMATES OF THE GEOLOGICAL PAST.

By H. J. JENSEN, D.Sc.

Read before the Royal Society of Queensland, 25th September, 1909.

The important discovery of the Shackelton Antarctic Expedition of coal seams, within a few degrees of the South Pole, at an elevation of 10,000 feet, is another piece of evidence that this elevated and frozen region was once situated near sea level, and was enjoying a warm or temperate climate.

The cause of an "Ice Age," and the cause of a warm cycle such as may produce a luxuriant tropical vegetation in Arctic regions, are subjects which have given rise to more controversy than perhaps any other scientific question, excepting the modern problems of radio-activity.

Although no single theory has been found adequate to account for an ice-age, still we get closer to the solution of the problem as the years roll on. The American School of Geologists, by their lucid reasoning, have done much to help clear up the question.

The ice-ages of greatest geological significance, that is, producing the most widespread effects, were the Cambrian Ice Age in the dawn of life on earth, the Permo-Carboniferous ice age in the period when coal measures were laid down, and the late Tertiary when Europe was covered with extensive glaciers, and an ice age prevailed on Mount Kosciusko and Tasmania.

The early Cambrian Era was a period of great continental extension and uplift. Either the continents rose and grew larger at the expense of the sea—or what really amounts to the same thing—the oceans grew deeper so that the waters sank or became confined to smaller areas. One of the results of this continental extension was that arms of the pre-Cambrian seas became isolated, and were turned into lakes situated at comparatively high altitudes.

During the Ordovician, Silurian and Devonian periods, which followed the Cambrian, the continents became largely worn down and resubmerged. This was the effect of the cessation of those uplifts of continents and subsidences of ocean basins that characterised the previous cycle. The continents would be worn down by rivers, and the oceans would tend to silt up, causing the waters to rise.

The carboniferous and early Permo-Carboniferous, which followed the Devonian, were periods of fluctuating conditions, as shown by the intercalation of land and swamp deposits, like coal beds, between marine sediments. The late Permo-Carboniferous and Triassic were periods of elevation or continental extension, and the most marked result of the inequalities in level produced was that some areas became cold and arid (like the Thibet and Gobi to-day), and other areas became cold and humid (like the west coast of Scotland to-day).

At the end of the Triassic, uplifts ceased, and the following periods, the Cretaceous and Eocene, saw the continents worn down and largely resubmerged. Absence of high mountains and the prevalence of marshy conditions naturally produced warm climates.

In the middle and late Tertiary periods which followed the Eocene, particularly in the Miocene and Pliocene, great uplifts again took place. This resulted in the production of high altitudes and cold climates. The Alps and the Himalayas, and many of our highest tablelands of to-day, were formed during these periods.

It is clear that the three greatest Ice Ages, the Cambrian, the Permo-Carboniferous, and the late Teritary, correspond with periods of uplift or "continental extension."

The researches of Professors Hull and Spenser show that Europe and North America stood many thousand feet higher in the period of the Great Ice Age than at present. The drowned valleys off the Victorian coast, and the rugged coastline of south-eastern Australia, show that this part of our continent was much higher when an ice-age prevailed on Mount Koscuisko, the Australian Alps, and in Tasmania.

It is therefore quite possible that the Ice Ages of geological history have all seen produced essentially by the

existence of much greater inequalities of level during these periods than exist at the present day. An average high altitude for the continents is, *per se*, quite capable of producing an ice age.

The periods of submergence, when continents were low and oceans were silting up, were periods of warm temperatures; they witnessed great organic evolution, and produced a rich flora in Arctic regions. Heer has shown that a bounteous plant life existed in Spitzbergen, and other far northern regions, in the Carboniferous, and again in the Cretaceous and Eocene, that is in the periods of continental submergence or oceanic extension. No such flora existed there in the Permian, or in the Triassic, which were periods of continental extension.

Professor Chamberlin, of Chicago, has ably shown that these periods of Arctic warmth can easily be accounted for if we assume that a reversal of deep-sea circulation has repeatedly taken place. Instead of, as at present, the surface currents running towards the poles, and the deep-sea drift moving towards the Equator, the surface currents flowed towards the Equator, and the deep-sea drift was polewards.

The drift of warm equatorial deep sea waters towards the poles would ameliorate the climate there, and produce conditions suitable for luxuriant vegetation. Professor Chamberlin has shown, both by mathematical and experimental investigation, that a slight increase in the amount of salt in the sea would reverse oceanic circulation in this way, and that an increase of evaporation in the tropics could easily produce the required increase in salinity of the ocean. Warm dense waters from equatorial parts would then rise in polar latitudes, and impart their heat to the atmosphere.

The total evaporation over the earth's surface is roughly proportionate to the area covered with water, and evaporation is greatest in the torrid zone. Therefore, the greatest evaporation in the tropics would take place when this part of the earth is almost wholly submerged. Such a condition obtained in the Carboniferous, Cretaceous, and Eocene periods, which, as mentioned above, were periods of a rich Arctic flora.

Enormous evaporation in equatorial regions led to salinity obtaining a greater influence than temperature over the specific gravity of sea water, hence the salinity controlled the manner of circulation. Heavy salt waters sank and drifted polewards from the equator, and lighter, fresher and cold waters formed surface currents from the poles to the equator.

Submarine eruptions, by pouring hot lavas into the sea, would cause increased evaporation and increased salinity, and would saturate deep-sea waters with carbonic acid, liberated partly from the lava itself, and partly from the decomposition of corals and coral limestone by the hot lava. The carbonic acid carried poleward in solution under pressure would be liberated as the waters rose to the surface. Carbonic acid thus liberated would be of great value to plant life, both because it is a plant food, and because it renders the climate warm and equable.

It is therefore clear that both the facts of an ice age and the phenomenon of a rich polar flora can be explained on very simple assumptions, and that there is no need to suppose those vast astronomical and physical revolutions which many theories have hypothesized.

M. Eugene Dubois, in a celebrated essay, tried to explain climatic variations on the earth, and also ice ages, on the assumption that the sun is a variable star. The objection to this view is that variability of the sun implies a harmonicus periodicity, and indeed, we possess no evidence to show that intervals between warm and cold periods of geological history were of equal duration. In fact, most of our data tend to disprove any regular periodicity. On Dubois's assumption, glaciation should also have been universal in the cold cycles, and simultaneous in the two hemispheres. This was not the case. Besides, M. Dubois's theory is unnecessary, far-fetched, and unproved.

There may be some variability in the amount of heat obtained from the sun in different epochs, but as the evidence which we possess, proves it to be of an irregular nature, it must be due to extra-solar or accidental causes. Effective causes of such fluctuation in solar heat might be either (1) the passing of our sun and planetary system through an excessively cold or hot region in space; or (2)

the entrance of the system into a region studded with meteorites. The first is of doubtful possibility, as there seems to be no reason why some regions of space should be hotter than others. The second is a more likely cause. It is easy to understand that if the sun entered a region of space particularly crowded with meteorites or cosmic dust, the first effect on the earth would be a cooling of climates, due to the meteorites intercepting much of the sun's heat before it reached the earth. The second effect would be a rise in the temperature of the sun consequent upon the meteorites falling into it. The objection to the second view is that some of the larger meteorites of such a period should remain fossilised in the geological record, which we cannot state to be the case.

If there should be any variability in the sun, the periods of hot sun would correspond with periods of slow contraction of our planet and warm climates, like the Cretaceous. Few or no great up-lifts or down-throws such as produce great inequalities on the earth's surface would take place in a period of slow, secular contraction, but the continents would be worn down by rivers, and sediments would be piled up in the ocean, and the waters would rise and submerge the lowlands.

Cold sun periods would accelerate the process of secular contraction. Great wrinkling of the earth's crust would take place. Continent building (epeirogenic) and mountain building (orogenic) uplifts would occur. The super-elevated regions become subject to cold and arid climates, whereas the lowlands acquire moist and cold climates, the diminished intensity of atmospheric circulation causing the atmospheric water to be precipitated excessively on the coastal plains.

An interesting view on the cause of an ice-age was recently advanced by Professor David. He showed that a drop of 40° in the earth's temperature would move the isotherm of permanent glaciation (or snow-line) into the tropics, and would produce just those conditions which are essential for the production of an ice-age in tropical and sub-tropical regions. Such a cold period might not necessarily be accompanied by severe glaciation in polar and temperate regions, for these parts would suffer from drought. There would be no evaporation outside tropical

regions, and all the vapour formed in the warm zone would be precipitated at the snow-line, where a great and continuous ice-barrier would form. North of the ice-barrier of the northern hemisphere, and south of that of the southern hemisphere, no snow would fall, and the ground might be perfectly free from snow and ice.

Croll's theory and Adhemar's hypothesis, and many other speculations are scientific curiosities of great interest, and are well known. Croll's hypothesis, though spurned by many, has such merits that even to-day it must be ranked as one of the best attempts ever put forward to explain the cause of an ice-age.

NOTE ON THE CALCULATION OF PERCENTAGES FROM VOLUMETRIC WORK.

By FRANK E. CONNAH.

Read before the Royal Society of Queensland, 25th September, 1909.

NOTE ON ESTIMATION OF ZINC IN COPPER ORES BY MEANS OF POTASSIUM FERROCYANIDE.

By FRANK E. CONNAH.

Read before the Royal Society of Queensland, 25th September, 1909.

The accurate estimation of zinc in copper ores by means of Potassium Ferrocyanide as usually recommended is one which is liable to give trouble, especially if the zinc is only present in small quantity. One is justified in feeling dubious as to the accuracy of results when a blue colour makes its appearance in the solution during the titration, it being almost a certainty that more ferrocyanide is being run in than is required for the zinc ions present; and while this trouble can usually be averted by introducing a small crystal of sodium sulphide into the solution, one can feel more confidence in the result obtained when the zinc is previously separated from the main solution and dissolved in a measured quantity of acid. Such a solution is free from oxidising agents and interfering salts, and approaches more nearly to the conditions of the standard.

The author has been using a process for several years for determining the zinc in copper ores which has invariably given excellent results. The precipitates obtained all allow of quick filtration, and when one is used to the details of manipulation the process can be quickly carried out. Briefly, it consists of the separation of manganese by nitric acid and chlorate of potash, iron by ammonia, copper by potassium thiocyanate, and the zinc then is thrown out as a phosphate to be dissolved in a measured quantity of acid, and titrated under standard conditions.

There are no new reactions in this, but the combination does not appear to have found a place in the journals and text books.

PROCESS.—The ore is treated in a casserole with strong nitric acid, which has been saturated with chlorate of potash, and the solution is evaporated to dryness without baking. Solid ammonium chloride is now introduced (about 10 grammes) and then about 25cc hot water, and the assay kept warm till the mass is disintegrated, then excess of ammonia is added, and the solution is filtered. Boiling should be avoided, as there is a tendency to form insoluble basic compounds of zinc. The precipitate is well washed with hot water containing ammonium chloride and ammonia. If the precipitate is bulky it is advisable to assist the washing by bringing the precipitate back into the casserole with the wash bottle (a cone of platinum in the filter is of great assistance).

The main lot of zinc and copper is now in the filtrate, but it is necessary to retreat the precipitate. If the process has been carefully carried out, only one retreatment will be necessary.

The ammoniacal filtrate (about 100cc) is rendered just acid with hydrochloric acid, boiled with a little sulphurous acid, and the copper is thrown out with a ten per cent. solution of potassium thiocyanate and sodium sulphite, added drop by drop to the solution at about 60° C. If only a little copper is present, the addition of a little cold water assists the formation of the precipitate.

To the filtrate a few drops of methyl orange are added and then 5 E hydrochloric acid till the neutral point is indicated, and then one drop more of the 5 E hydrochloric acid. The solution is now heated to boiling, and the zinc precipitated by addition of ammonium phosphate, the solution being kept warm for a few minutes till the precipitate becomes granular. Care must be taken here to avoid bumping.

The precipitate is readily filtered off, and is then treated, with the filter paper, in a beaker with 150cc hot water and 5cc strong hydrochloric acid, and titrated at 60° C. with standard potassium ferrocyanide as usual.

In dealing with ores which contain under one per cent. of copper, a very good alternative method is to take the ammoniacal filtrate from the iron, and after adding the required excess of acid add a small crystal of sodium

sulphide, and titrate with the copper sulphide precipitate present. If the sodium sulphide be used in the form of crystal, the copper sulphide forms a dark precipitate, whereas if a solution were used a brown coloration of the liquid would result, which would interfere with the subsequent titration.

THE ORIGIN AND OCCURRENCES OF PHOSPHATE ROCK AND THE POSSIBILITY OF FINDING PHOSPHATE DEPOSITS IN AUSTRALIA.

By H. J. JENSEN, D.Sc.

Read before the Royal Society of Queensland, 30th October, 1909.

Phosphoric Acid, which is an important plant food, is constantly being extracted from the soil wherever intense grazing or cultivation is practised. In our native scrubs, where the plants and animals on dying leave their remains on the ground, most of the phosphoric acid is returned to the soil, but when the beasts and plants of the field are taken to the cities for consumption no such restitution of phosphoric acid takes place ; and to prevent the land from becoming absolutely exhausted the addition of mineral fertilisers containing phosphate is essential. It is therefore clear that from a national and economic standpoint prospecting for phosphoric acid is a more useful occupation than hunting for gold.

SOURCE OF PHOSPHATE DEPOSITS.

Most of the phosphate deposits of commercial value throughout the world occur in sedimentary rocks, but occasionally large bodies of mineral phosphate (Apatite) are directly the product of igneous activity, as in Canada, Norway, and Estremadura in Spain.

Primarily all the phosphate of sedimentary rocks was derived from igneous rock. All igneous rocks contain phosphoric acid in small amounts, varying from .01 o 5.00 %. It occurs in the form of apatite (phosphate of lime with fluoride or chloride of lime), in small needles which crystallised out in an early stage of the consolidation of the rock. As apatite is generally one of the most soluble of the minerals of igneous rocks, it readily passes into the soil, where it is taken up by plants and into the animals which live on the plants, or it passes into the rivers in solution and thence to the sea, where it is taken in by fishes, corals, molluscs, and

other organisms. These latter are again eaten by sea birds, which excrete much of the phosphoric acid in their droppings. Phosphates in sedimentary rocks may therefore be derived from (1) bird, seal or fish excrements; (2) bones of fishes and other animals; (3) shells of molluscs, molluscoids, crustacea, corals, foraminifera, etc.; (4) remnants of swamp vegetation. Phosphoric acid, like carbon, is constantly changing its place between the organic and inorganic world.

MODE OF OCCURRENCE AND ORIGIN.

Apatite occurs in all rocks in small amount, and, being the most soluble mineral in igneous rocks, it easily passes away into sedimentary formations and the sea to be absorbed into organic life when the rock decomposes. But apatite of this kind is of no commercial value, the percentage in igneous rocks being too small for profitable separation. In some cases, however, large dykes and sheets of pure apatite occur in igneous rocks and in metamorphic sedimentary rocks in proximity to great plutonic intrusions. The most notable instances are the Canadian and Norway occurences. In such cases profitable mining is possible. The origin of these dykes and intrusive sheets is due to vapour action in the period of cooling of the great igneous masses with which they are conected. Vapours or hot waters containing phosphoric, hydrochloric and hydrofluoric acids have circulated in the cracks and joints formed by the cooling of the magma, or formed in the adjoining sedimentary formations by the thrust of the intrusion. In these passages the phosphoric acid has been precipitated in combination with calcium.

Phosphorite occurs associated both with igneous and sedimentary rocks. It may occur either as veins in igneous rock, or bedded in sedimentary or metamorphic rocks, or in lenticular bodies infilling former caverns in limestones, or as an alteration product of limestone underlying guano deposits. In igneous rocks it may be either a primary product of vapour action like the apatite described above, or a secondary product formed by the alteration of calcite veins by solutions containing phoshporic acid from overlying guano beds.

Secondary phosphorite owes its phosphoric acid to the decomposition of organic remaius. Guano, bone breccia, decaying animal and vegetable matters have the soluble

phosphates of lime (dicalcic phosphate), magnesium, and ammonium leached out by meteoric water containing carbon dioxide. The soluble phosphate solution filtering down come into contact with carbonate of lime, either in the form of limestone or calcite, and alters it to the phosphate, liberating at the same time carbon dioxide.

The origin and mode of occurrence of guano has already been referred to.

High grade apatite and phosphorite should contain from 70 % to 80 % tricalcic lime phosphate.

The occurence of phosphorite deposits at the junction of two formations of a different character is not unusual, especially when the lower rock is fossiliferous limestone; and its occurrence where there is an unconformity between two formations or a thinning out of a fossiliferous stratum is also well known. It is very often associated with arragonite and not seldom with calamine.

GENERAL CONSIDERATIONS.

From the foregoing description of occurrences of phosphate rocks (not considering the apatite and guano deposits), it will be seen that phosphorite may originate

(1) from the insoluble residue of leached guano;
(2) from the action of ammonium phosphate derived from guano beds on limestone;
(3) as a breccia from the erosion of partly phosphatised limestone;
(4) from the leaching of bone beds;
(5) from the decomposition of plant remains in dried up swamps;
(6) from the leaching of coral limestone, foraminiferal limestone, molluscan limestone, and brachiopod limestone. In such cases the phosphate deposits may be in pockets either on the surface of the limestone under the soil, or underlaying the limestone on its junction with the subjacent formation.

Aluminous phosphates originate by the action of ammonium phosphate from guano, decomposing organic matter, bones, etc., on trachytic or basaltic rocks or kaolin.

A notable observation is that phosphates often occur at the unconformable junction between two different geological horizons. Thus phosphates occur at the junction

of the Cambrian and Silurian at Nerike in Westergotland, Sweden. The overlying Silurian limestone is rich in phosphatic nodules and glauconite, and almost everywhere in Sweden it has been observed that the Lower Silurian begins with a glauconitic bed with phosphatic concretions. The phosphatic nodules are probably derived by the concretionary action of water charged with phosphoric acid from the decomposition of brachiopod beds containing obolus and acrothele. There is always a break in the faunal sequence where phosphatic nodules occur. The matrix contains a mixture of two fanuas, due in part to weathering by subærial denudation. In the Cambrian Bala Beds of North Wales it is trilobite remains which have given rise to phosphatic concretions. In the New Brunswick deposits we have sand and glauconite cemented by phosphate of lime, and the nodules always contain trilobite remains, sponge spicules, and protozoan tests.

In the Liassic strata of Lorraine and of the Mendip Hills, and in the Oxford clays phosphatic nodules occur. In the latter stratum they contain casts of cephalopods, lamellibranchs, echinoderms, phosphatised sponges and wood, concretionary masses, bones, teeth, coprolites of fishes and saurians, and pebbles of phosphatised sandstone, and compact phosphate.

In the Devonian of Tennesse above the Chatanooga Black Shale, there is also a nodular deposit containing glauconite.

These nodular deposits have been almost universally ormed along former shore lines, where erosion of coral, trilobite, molluscan and brachiopod limestone was going on by subaerial agencies and phosphatic concretions were washed out into the coastal muds just at or below low tide limit. For this reason, too, the phosphate beds always occur where beds thin out as well as where an unconformity occurs. Thus the phosphatic bed overlying the Chatanooga shales in Tennessee is only seven to eight feet thick, but in Virginia the same bed is 400 feet thick and contains no phosphatic nodules.

Phosphates may also form by direct deposition in deep water in association with glauconite. Some of the palœozoic and mesozoic beds of phosphatic nodules and glauconite may have their origin.

The Challenger soundings off the Cape Agulhas Bank brought up phosphatic nodules and glauconite sand from a depth of 1,900 fathoms. Murray and Renard show that such deposits form particularly off continental borders and where currents of different temperatures meet, and where consequently great destruction of organic life is going on.

GUANO DEPOSITS.

Guano may often occur unleached on rainless islands or in rainless coast districts, as on or off the west coast of South America. It may also occur in caves. as at Olsen's Caves near Rockhampton, Queensland. It is composed chiefly of the excrement of seabirds when found on islands or on the coast, and when found in caves it is usually the dung of bats.

WHERE PHOSPHATES MIGHT BE EXPECTED IN AUSTRALIA.

(*A*) *Apatite.*—In many parts of Australia we have Archœan, Cambrian and ancient palœozoic schists and gneisses intruded by gabbroic plutonic rocks. In the Mount Lofty Ranges and Yorke Peninsula of South Australia, the Australian Alps of New South Wales and Victoria, in the Broken Hill district, in both Southern and Northern Queensland, very ancient schist formations are met with, and where such formations are intruded by highly titaniferous gabbros and norites apatite veins might be expected. In the Northern Territory of South Australia and Western Australia it is likewise possible that apatite veins of commercial value may yet be found.

The country lying to the west of the D'Aguilar Range in Southern Queensland consists largely of gneisses. amphibolites, and schists, having an older appearance than any other met with in Australia. In many localities in this area the schist formations are intruded by gabbross, and the entire area being a titaniferous province, the chances of finding payable apatite here are not bad. This is the only likely locality with whose detailed geology I am personally acquainted.

(*B*) *Phosphorites.*—These minerals might be met with in pockets in any of the Palœozoic limestones of Australia, and possibly as beds in such limestone. Many of our Cambrian, Silurian and Devonian limestones were re-

markably rich in life—molluscan, pteropod, brachiopod, trilobite, coral and foraminiferal remains constituting large limestone formations. Thus the beds of the Devonian limestone of the Currockbilly Range of New South Wales are almost wholly composed of brachiopods. Where such formations are followed by an unconformity, and contemporaneous erosion of the deposit has taken place, rich pockets of phosphorite are possible. An unconformity would be recognised by the prospector if he sees a change in the dip of the overlying strata from that of the limestone, and notices at the same time that immediately above the latter formation comes a bed of coarse shingle.

In these palœozoic limestones glauconitic phosphate rock of deep-sea deposition might be met with. Such deposits would probably be of a dark colour, due to manganese staining and might contain remains of deep-sea trilobites (blind forms), cephalopods, pteropods, and sponges with micro-organisms belonging to the foraminifera, radiolaria, infusoria, and diatoms.

It now behoves us to consider if in Australia we may anywhere expect a counterpart of the Florida phosphates. In Florida we had an elevation of Tertiary limestone deposits accompanied by drying up of salt marshes and by an inroad of mammals driven south by the great Ice Age. As the marshes dried up and the cold increased the animals died in large numbers of starvation and left their bones in caves and solution fissures of the limestone. Bats and birds preying upon the carrion left their guano in caves and fissures. The limestone, itself rich in phosphoric acid from the high proportion of foraminifera in it, was further enriched in that ingredient by leaching out of carbonate of lime.

In Australia we have had no great universal Ice Age in Tertiary times, but for all that we have had an almost equal extermination of animal life by the desiccation of the now arid interior. It is believed by Australian geologists that until the Pliocene or early Pleistocene, large stretches of the desert interior were covered with vast lakes. Where the land now lies scorched and parched the rain then fell in copious amount. Vast herds of giant marsupials lived around these lakes and along the streams that watered them. Granually the climate got drier and drier. The animals of the Australian Interior would as a result be scattered in

two opposite directions. As the lakes diminished in size and the damp zone around them grew smaller, great herds of animals would draw together around their waters and die of thirst when finally a drought dried up their drinking supplies. In many parts of our interior great masses of bones of extinct animals are found, and where such is the case the neighbouring rock is likely to be a phosphatic limestone, as we remember that limestone in particular has a preservative action on bones.

While some of the animals of the interior migrated inwards towards the drying up lakes, other troupes migrated outwards towards the Gulf of Carpentaria and the Great Australian Bight. In both of these areas a considerable elevation has taken place in Pleistocene times, and Tertiary deposits, essentially limestone rich in foraminifera, have been raised high and dry, just as the Pleistocene of Florida has been elevated. These troupes of animals always hugging the moist coastal regions would in droughty years die in great numbers, and their remains, when falling upon foraminiferal limestone or in cracks and crevices of such a formation, would give rise to phosphatic limestone or secondary phosphorite. It is therefore possible that in the Tertiary limestones, both of the Australian Bight and of the Gulf of Capentaria, pockets of rich phosphatic rock, similar to that of Florida, might be met with.

(*C*) *Bone Beds in Limestone Caves.*—Several years ago when rambling through some of the Chillagoe Caves of Northern Queensland, I came upon some caves which contained on the floor a bone bed at least several feet in thickness. This occurrence is probably not an isolated one, but common in our Northern limestone country. In such bone caves phosphate rock of commercial value is possibly to be found.

(*D*) *Guano.*—In our limetsone formations, and especially near the coast of Tropical Australia, where luxuriant shrubs provide abundant feed for all varieties of animals, large caves containing great thicknesses of bat guano are commonly met with. A notable example is the occurrence of guano at Olsen's Caves, near Rockhampton, in Central Queensland.

To summarise, phosphate deposits may occur in Australia,

(*a*) as apatite in very old schist and gneiss formations that have been intruded by basic igneous rocks.

(*b*) as phosphorite in palœozoic limestones, where unconformities occur above them, and leaching by subaerial agencies may have taken place.

(*c*) as phosphorite in Tertiary limestones, where animals have died in large numbers on the desiccation of our interior in Pleistocene times. Such occurrences might be met with in Central Australia, and round the shores of the Australian Bight and the Gulf of Carpentaria.

(*d*) as bone breccia in limestone caves.

(*e*) as guano deposits in limestone caves.

INTRODUCTION OF ECONOMIC PLANTS INTO QUEENSLAND.

By J. F. BAILEY.

Presidential Address read before the Royal Society of Queensland, February 26, 1910.

From my position as Director of the Brisbane Botanic Gardens, it may be expected that my presidential address would deal with some subject appertaining to plant life, and it has occurred to me that it would be well to freshen the memory by a few notes as to whom we are indebted for the introduction and distribution of many of the economic plants now being largely cultivated in this State, as well as others of which trials have been made. The majority of these benefactors have passed away, but their good work for the State is largely in evidence around us at the present day. To many the names of the introducers of the plants, or the first cultivators of them, are unknown, therefore it is hoped that these notes will furnish a useful record for future reference.

Queensland stands pre-eminent among the States of the Commonwealth of Australia with regard to the number and variety of economic plants found in cultivation within her boundaries, the great diversity of climate experienced enabling plants from all parts of the world to find a home in one or another part of her large territory.

Unfortunately, a number of those responsible for the introduction of plants in the early days kept little or no record of their work, a circumstance which has rendered it difficult in compiling information.

So far as I am able to gather, the Brisbane Botanic Gardens, an institution formed in 1854, is responsible

for the introduction and distribution of a very large number of the economic plants grown at the present day, and in the early days of settlement it assumed the functions now performed by the State Farms. The name of Walter Hill, who was the first Director, and occupied the position until 1880, will ever be remembered, for it was due, in a large measure, to his efforts that such successful work was done in this direction.

The Acclimatisation Society, which was formed in 1862, has also been instrumental in forwarding this good work, and worked side by side with the Brisbane Botanic Gardens. Indeed, during the first year or two, plants introduced by the Society were intrusted to the keeping of the Gardens, until Bowen Park, the home of the Society, was ready for their reception. In connection with the work of the Acclimatisation Society, the name of L. A. Bernays, C.M.G., who, by the way, was a past president of our Society, will always be closely associated, for it was principally due to his indefatigable energies that the Society has earned such a world-wide reputation. The Society was fortunate that the mantle of this worthy gentleman fell on another enthusiastic worker. I refer to Leslie G. Corrie, who, since he succeeded Mr. Bernays in 1896, has interested himself in continuing the good work previously performed, especially with regard to sugar cane, pineapples, and bananas. Valuable assistance has also been rendered by W. H. Parker, the Vice-President of the Society.

Among those who gave practical demonstration of their interest in the work under notice, J. G. Cribb stood in the front rank, he being the introducer of many of the kinds of American fruits now being grown in the State.

One of the early introducers of economics was J. C. Bidwill who, between the time of his appointment as Lands' Commissioner in 1848 and his death early in 1853, is said to have imported quite a number of interesting plants, the best of which were removed, after his death, to the Sydney Botanic Gardens, and although I can find no list of those taken away, I believe they were included in the economics sent from that institution in 1854 to M. C. O'Connell, at Port Curtis, and to a gardener in Brisbane, and mentioned in the annual report of the Sydney Botanic Gardens for that year. G. W. Dart, a very old resident

of Maryborough, in a letter recently written to C. H. Hughes, of the same town, states that most of the kinds of fruits now grown about Maryborough were growing in Mr. Bidwill's garden at Tinana, ... and that the large tree of Hovenia dulcis growing at Tinana was planted by that gentleman.

While Government Resident during the middle fifties, Captain Wickham was instrumental in introducing quite a large number of useful plants, which he cultivated at Newstead. For information as to the kinds grown, I am indebted to Robert Lane, now of the Parliament House staff, but who in those days was gardener to Captain Wickham. Mr. Lane also informed me that about the same time R. R. McKenzie had a good collection of fruits, etc., in his garden near the Bulimba point. About the same time the Hon. Louis Hope, of Cleveland, imported quite a number of useful plants, many of which he shared with the Brisbane Botanic Gardens.

With regard to the cultivation of fruits, etc., on the Darling Downs, I cannot obtain definite information on the subject, but Benjamin Crow, a well-known and very able horticulturist of Toowoomba, informs me that when he went as gardener to Dr. Nelson (father of Sir Hugh Nelson, K.C.M.G.), at Gabbinba, in the sixties, that gentleman had growing apples, peaches, figs, grapes, which appeared to be about 10 years old, and Mr. Crow planted oranges. Dr. Nelson was interested in experimenting with various plants likely to become useful, and at the time mentioned had hops and raspberries thriving. During the early sixties Mr. Penticost planted a small orangery near Toowoomba, and Messrs. Bushnell and Molde, in addition to the above mentioned fruits, had nectarines in their orchards. About this time, Mr. Crow states, good collections of fruits were grown at the following stations :—Gowrie (Mr. King's), Glengallan (Mr. Deucher's), Talgai, Eaton Vale, and others.

Dr. Joseph Bancroft, another of our past presidents, must also be included among those who worked in this direction, especially with regard to vines and Indian wheats.

The different nurserymen of Queensland have not been forgetful of the advantages to be derived by the intro-

duction of economics. Among the early ones we must record the names of A. J. Hockings, S. H. Eaves, E. Way, — Magill, Alfred Williams, of Brisbane, and C. H. Hartmann, of Toowoomba. Mr. A. T. Hockings informed me that in one of his father's letter-books is a copy of a letter dated 31st January, 1857, addressed to the Curator Botanic Gardens, Calcutta, in which he ordered the following plants:—Sweet Sop, Sour Sop, Mangosteen, Mango, Litchi, Longan, Wampee, Jack Fruit, Avocado Pear, Durian, and Boehmeria nivea.

On several occasions attempts have been made to introduce economic plants on the islands within the Barrier Reef. In the early seventies, Captain Bedwell, of H.M. Surveying Schooner "Pearl," on behalf of the Brisbane Botanic Gardens and the Acclimatisation Society, planted Jack Fruit and Pandanus utilis. In the early nineties, cocoanuts, mangoes, peaches, and other fruit trees were planted at the instance of the Department of Agriculture.

It is to be regretted that very few, comparatively speaking, of the many good things introduced in the early days, could be traced in any gardens in the State twenty years since, although thousands were distributed. However, on the formation of the Department of Agriculture, in 1888, the work of re-introducing many of the most desirable kinds was taken up, with the result that the State farms and nurseries at the present are stocked with a fine collection of economic plants of every description.

The statistics quoted herein are taken from the Annual Reports of the Queensland Government Statistician (Thornhill Weedon, F.S.S.). I also found A. Meston's Geographical History of Queensland useful in obtaining information concerning crops cultivated in the early days.

The following must not be taken as a complete list of the economic plants which have been introduced, but only those which have been given a trial in cultivation, for it must be borne in mind that very many of the kinds introduced did not progress further than the pot stage.

RUBBER.

INDIA RUBBER (*Ficus elastica*).

Growing in the Brisbane Botanic Gardens in 1867.

INDIA RUBBER VINE (*Cryptostegia grandiflora*).

Introduced during the early seventies by Brisbane Botanic Gardens and Acclimatisation Society.

PARA RUBBER (*Hevea brasiliensis*).

Growing in the Brisbane Botanic Gardens in 1877. Seeds imported by the Department of Agriculture, in 1889, and plants now growing at Kamerunga.

PANAMA RUBBER (*Castilloa elastica*).

Planted out in the Acclimatisation Society's gardens in 1882.

CEARA RUBBER (*Manihot glaziovii*).

Planted in Brisbane Botanic Gardens in 1882. A plantation growing at Mourilyan Harbour early in the nineties.

AFRICAN RUBBER (*Funtumia elastica*).

Planted at Kga, S.N., about 12 years ago. Raised at Brisbane Botanic Gardens in 1906.

EDIBLE NUTS.

QUERCUS CORNEA.

Introduced by the Brisbane Botanic Gardens in 1876.

BRAZILIAN NUT (*Bertholletia excelsa*).

Introduced by the Brisbane Botanic Gardens in 1873, and again in 1883, and distributed to establishments in the North in 1887. One of the plants introduced in 1883 is growing in the Gardens, but has made slow progress.

SPANISH CHESTNUT (*Castanea sativa*).

Growing in the Brisbane Botanic Gardens and at Bowen Park in 1866, and distributed from last mentioned place in 1875.

PECCAN NUT (*Carya olivaeformis*), and

HICKORY NUT (*C. alba*).

Distributed from the Brisbane Botanic Gardens in 1874. and one of the trees of the former raised by Mr. Aldridge, of Maryborough, has borne good nuts for some years past.

WALNUT (*Juglans regia*).

Plants distributed from the Brisbane Botanic Gardens in 1874.

CULINARY VEGETABLES.

Many of the well-known culinary vegetables were grown in the year 1826, when a convict settlement was established here.

In 1828, Potatoes (*Solanum tuberosum*) were grown at the penal establishment at Ipswich, and Backhouse

and Walker saw Sweet Potatoes (*Ipomaea batatas*) growing at Brisbane in 1836. The following are some of the varieties since introduced :—

JERUSALEM ARTICHOKE (*Helianthus tuberosus*).
By A. J. Hockings in the early sixties.

TREE TOMATO (*Cyphomandra betacea*)
By the Acclimatisation Society in 1885.

CHOCHO (*Sechium edule*)
By L. A. Bernays, C.M.G., at suggestion of Sir Anthony Musgrave, in 1888.

SWEET CORN (*Zea Mays, vars.*)
Several varieties were introduced and distributed by the Department of Agriculture in 1891.

SWEET POTATOES (*Ipomaea batatas*).
Most of the best varieties owe their presence in this State to the efforts of the Acclimatisation Society. In 1907 the produce from 2770 acres was 15,888 tons.

YAM (*Dioscorea sativa*).
Grown by T. Petrie at North Pine, prior to 1869, in which year the Acclimatisation Society imported several varieties from the South Sea Islands.

GRASSES AND OTHER FODDER PLANTS.

PERENNIAL RYE (*Lolium perenne*).
Introduced by the Acclimatisation Society in 1865.

PRAIRIE GRASS (*Bromus unioloides*).
Seeds received by Acclimatisation Society in 1865 from Hon. W. H. Groom, Toowoomba, who stated that it had proved successful on the Darling Downs.

BUFFALO GRASS (*Stenotaphrum americanum*).
Growing at Brisbane Botanic Gardens and at Bowen Park in 1868. Distributed from first-mentioned place in 1874 for binding railway embankments.

GUINEA GRASS (*Panicum maximum*).
Introduced by Acclimatisation Society in 1867.

RED NATAL GRASS (*Tricholaena rosea*).
Introduced by Acclimatisation Society through Dr. Schomburgh of the Adelaide Botanic Gardens in 1870, and now become naturalised in many parts of the State.

SORGHUM (*Sorghum vulgare*).
Varieties introduced by the Acclimatisation Society in 1865. Numerous varieties have been introduced

by the Department of Agriculture during the past twenty years. James Henderson, of Tambourine, is said to have imported Kaffir Corn during the eighties.

PANICUM (*Setaria italica*).

Growing in the Brisbane Botanic Gardens prior to 1871.

KENTUCKY BLUE GRASS (*Poa pratense*).

Introduced by Acclimatisation Society in 1877.

TEOSINTE (*Euchlaena luxurians*).

Introduced by the Brisbane Botanic Gardens and Acclimatisation Society in 1878.

CATERPILLAR GRASS (*Paspalum dilatatum*).

Introduced by John Mahon, Principal, Queensland Agricultural College, who brought it from New South Wales, in 1897.

OATS (*Avena sativa*).

Oats were grown at the penal settlement at Ipswich in 1828. Grown extensively since the fifties, about 17,000 acres being under cultivation in 1908.

RYE (*Secale cereale*).

In 1877, the Acclimatisation Society distributed seed which had been received from Angas Mackay. It is said that Dr. Joseph Bancroft first cultivated this about Brisbane for fodder.

WONDER GRASS or GIANT COUCH (*Panicum muticum*).

Obtained by Dr. Joseph Bancroft in the seventies, from, I believe, Dr. Schomburgh, the Director of the Adelaide Botanic Gardens.

CANARY GRASS (*Phalaris nodosa*).

Growing at Toowoomba Botanic Gardens in E. Way's time, in the seventies.

CLOVERS—THE RED CLOVER (*Trifolium pratense*), and the WHITE CLOVER (*T. repens*).

Were introduced by the Acclimatisation Society in 1865, and the latter has become naturalised on many of our pasture lands.

LUCERNE (*Medicago sativa*).

Growing about Brisbane in the early sixties.

The following have been introduced on account of their reputation in other countris for bearing pods suitable

for fodder, but, so far as I am aware, no satisfactory results have been attained.

CAROB BEAN (*Ceratonia siliqua*).

Growing in the Brisbane Botanic Gardens and at Bowen Park in 1866, and distributed from the last-mentioned place in 1871. In 1890, seeds gathered from trees growing at the Park were distributed.

ALGAROBA BEAN (*Prosopis juliflora*) and
MESQUIT (*P. pubescens*)

Were introduced by the Brisbane Botanic Gardens and Acclimatisation Society in 1877. Received from Honolulu.

RAIN TREE (*Pithecolobium Saman*).

Distributed by Acclimatisation Society in 1880.

OILS.

CASTOR OIL (*Ricinus communis*).

Growing at Botanic Gardens in 1861, and since become a great weed on our waste lands.

CITRONELLA OIL (*Andropogon Schoenanthus*).

Growing in the Brisbane Botanic Gardens in 1872.

CROTON OIL (*Croton tiglium*).

Growing in the Brisbane Botanic Gardens and at Bowen Park in 1866.

GINGELEY (*Sesamum indicum*).

Growing in the Brisbane Botanic Gardens in 1871, and introduced in 1889 by the Department of Agriculture.

OLIVE (*Olea europea*).

According to L. A. Bernays, in "The Olive in Queensland," it would appear that W. Cairncross was the first to grow this plant, having set out eight trees at Bulimba in 1858. Importations were made by the Brisbane Botanic Gardens, the Acclimatisation Society and F. M. Bailey, in the sixties, and by the Department of Agriculture in 1889.

OIL PALM (*Elaeis guineensis*).

Planted in the Brisbane Botanic Gardens in 1861, and still alive, but does not appear as if it would last much longer. Those planted at Kamerunga State Nursery in about 1890 have fruited during several years past.

GROUND NUT (*Arachis hypogaea*).

Two thousand "nuts" were distributed from the Brisbane Botanic Gardens in 1875.

RUSSIAN SUNFLOWER (*Helianthus annuus*).

Introduced and distributed by the Department of Agriculture in 1888.

COCOA NUT (*Cocos nucifera*).

Although the Cocoanut was early introduced, it was not until about 1867 that a proper plantation was formed, and that by a Mr. Barnes in 1867, at Mackay. In 1880, the Acclimatisation Society distributed 800 nuts, received from Singapore, among the northern planters. Shortly after its formation, 10,250 nuts were planted by the Department of Agriculture on the islands within the Barrier Reef. The North Queensland planters are evidently not fully alive to the value of this useful palm, otherwise they would follow the example of others in New Guinea, Solomon Islands etc.

DYES.

LOGWOOD (*Haematoxylon campeachianum*).

Growing in the Brisbane Botanic Gardens in 1861, and there are three of the original trees now standing.

INDIGO (*Indigofera tinctoria*).

Introduced about 1861 by the Brisbane Botanic Gardens. Distributed by the Acclimatisation Society in 1872, and by the Department of Agriculture in 1890.

ANNATTO (*Bixa orellana*).

Growing in the Brisbane Botanic Gardens in 1861.

MADDER (*Rubia tinctoria*).

Introduced by the Brisbane Botanic Gardens prior to 1871.

SAFFLOWER (*Carthamus tinctorius*).

Growing in the Brisbane Botanic Gardens in 1871, and at the Mackay and Kamerunga State Nurseries in 1889.

NOPALEA COCCINELLIFERA.

This plant and the cochineal insect were, according to Walter Hill, thriving in the Brisbane Botanic Gardens in 1871.

FIBRES.

COTTON (*Gossypium spp.*)

Cotton was one of the earliest crops grown, for we find that in the year 1827, thirty acres were under cultivation at a branch penal settlement at Stradbroke Island. After this settlement was broken up, a lapse of some years occurred before resumption. In 1861, the following varieties were growing in the Brisbane Botanic Gardens :—

SEA ISLAND (*G. barbadense*). Chester, New Orleans, Honduras, Boyd's Prolific and Dean's.

UPLAND (*G. hirsutum*). Patte's Gulf and Peruvian.

In 1862, samples grown in various localities from Cleveland to Rockhampton were sent to the International Exhibition, London. In 1869, 14,000 acres were being cultivated. For several years prior to 1889, very little was grown, but the industry was again revived in that year, when the Department of Agriculture imported and distributed a large quantity of American seed to farmers in the West Moreton District. In 1908, the production from 540 acres was 17,521lbs.

JUTE (*Corchorus capsularis* and *C. olitorius*).

Growing in the Brisbane Botanic Gardens in 1862. During 1876 and 1877 the Acclimatisation Society endeavoured to start this industry by distributing about half-a-cwt. of seed to growers in localities from Brisbane to Mackay.

NEW ZEALAND FLAX (*Phormium tenax*).

Growing in the Brisbane Botanic Gardens, and in the garden of the Hon. Louis Hope, at Cleveland, in 1861.

MANILA HEMP (*Musa textilis*).

Growing in the Brisbane Botanic Gardens, and in the gardens of Mr. Warner, Brisbane, and Hon. Louis Hope at Cleveland, prior to 1862.

SUNN HEMP (*Crotalaria juncea*).

Introduced by the Brisbane Botanic Gardens in 1871.

SCREW PINE (*Pandanus utilis*).

Growing in the Brisbane Botanic Gardens in 1871.

FLAX (*Linum usitatissimum*).

Growing in the Brisbane Botanic Gardens in 1871.

BOWSTRING HEMP (*Sansevieria zeylanica*), and

AFRICAN HEMPS (*S. cylindrica* and *S. guineensis*).

Growing in the Brisbane Botanic Gardens in 1862.

BROOM CORN (*Sorghum saccharatum, var.*)

Has been grown extensively during the past twenty years.

MAURITIUS HEMP (*Furcraea gigantea*).

Introduced by the Brisbane Botanic Gardens during the sixties.

SISAL HEMP (*Agave rigida v. sisalana*).

Introduced by the Department of Agriculture, one thousand plants having been received from Yucatan in 1892.

ABUTILON PERIPLOCIFOLIUM.

Introduced by the Department of Agriculture from Trinidad in 1890.

RAMIE (*Boehmeria nivea*).

Introduced by the Brisbane Botanic Gardens about 1860, and ten thousand plants were distributed from there in 1873.

MULBERRY (*Morus alba*, and other species).

Introduced for purposes of silk-culture by Brisbane Botanic Gardens, the Acclimatisation Society and F. M. Bailey, about 1865. 4,500 cuttings were distributed from the Brisbane Botanic Gardens in 1873.

HEMP (*Cannabis sativa*).

Growing in the Brisbane Botanic Gardens in 1873.

SPICES, CONDIMENTS, PERFUMES, Etc.

CLOVE (*Caryophyllus aromaticus*).

Plants were sent to M. C. O'Connell, Port Curtis, and to a gardener in Brisbane from the Sydney Botanic Gardens in 1854. Plants were growing in the Brisbane Botanic Gardens in 1861, and a distribution was made from there and from Bowen Park in 1867 and 1874.

CINNAMON (*Cinnamomum officinalis*).

Plants were sent to M. C. O'Connel, Port Curtis, and to a gardener in Brisbane, from the Sydney Botanic Gardens in 1854. Growing in Captain Wickham's garden in 1856, and in the Brisbane Botanic Gardens in 1861, 30 plants being distributed from there in 1867

and 1874, and a number from Bowen Park in 1866, 1867, and 1874.

GINGER (*Zingiber officinale*).

Was grown at Brisbane Botanic Gardens and by A. J. Hockings prior to 1862. 160 rhizomes were distributed from the Gardens during the year mentioned.

ALLSPICE (*Pimenta communis*).

Plants sent to M. C. O'Connell, Port Curtis, and a gardener in Brisbane from the Sydney Botanic Gardens in 1854. In Captain Wickham's garden at Newstead, and in the Brisbane Botanic Gardens in 1856 and 1861 respectively.

BLACK PEPPER (*Piper nigrum*).

Growing in the Brisbane Botanic Gardens in 1861.

NUTMEG (*Myristica fragrans*).

Growing in the Brisbane Botanic Gardens in 1861. and at Bowen Park in 1866, and distributed from the latter place during same year.

CAPER (*Capparis spinosa*).

Growing in the Brisbane Botanic Gardens in 1861.

CAYENNE PEPPER (*Capsicum spp.*)

Pepper made from fruits grown by Mr. Giles, of Widgee Widgee, Wide Bay District, was shown at International Exhibition, London, in 1862.

VANILLA (*Vanilla planifolia*).

Growing in the Brisbane Botanic Gardens and at Bowen Park in 1866. Distributed to northern localities in 1866, 1872, 1874 and 1885.

PATCHOULI (*Pogostemon Patchouli*).

Introduced by the Brisbane Botanic Gardens prior to 1872.

TURMERIC (*Curcuma longa*).

Growing in the Brisbane Botanic Gardens in 1871.

CARDAMON (*Elettaria cardamomum*).

Plants and seeds were distributed by the Acclimatisation Society in 1885.

TONQUIN BEAN (*Dipteryx odorata*).

Plants growing in Brisbane Botanic Gardens in 1871, and a number received from Royal Gardens, Kew, in 1873. Some recently raised at Gardens from seed imported by Department of Agrculture.

MEDICINAL.

CAMPHOR (*Cinnamomum Camphora*).

Growing in Captain Wickham's garden at Newstead in 1856, and in the Brisbane Botanic Gardens in 1861. Was introduced for the sake of the valuable product obtainable from the tree, but is only grown as a shade tree, it being one of the best exotics suitable for this purpose. In other parts of the world it is being extensively grown for the production of camphor.

LIQUORICE (*Glycyrrhiza glabra*).

Introduced by the Brisbane Botanic Gardens in 1871.

NUX-VOMICA (*Strychnos nux-vomica*).

Introduced prior to 1871 by the Brisbane Botanic Gardens, and one of the trees now in the Gardens fruits freely every year.

PERUVIAN BARK (*Cinchona spp.*)

In 1862, *C. Calisaya*, the "Yellow Bark" was growing in the Brisbane Botanic Gardens, and in 1867, *C. succirubra*, the "Red Bark," and *C. officinalis*, the "Brown Bark," were received from Java. Plants of the two last-mentioned species were distributed by the Acclimatisation Society in 1880.

SENNA (*Cassia spp.*)

Plants of several species were growing in the Brisbane Botanic Gardens in 1865, and distributed from there in 1874.

IPECACUANHA (*Cephaelis ipecacuanha*).

Plants were sent to the Brisbane Botanic Gardens from the Royal Gardens, Kew, in 1873.

OPIUM POPPY (*Papaver somniferum*).

Growing in the Brisbane Botanic Gardens in 1875.

COCA (*Erythroxylon Coca*).

Growing in the Brisbane Botanic Gardens in 1877.

TANS.

DIVI DIVI (*Caesalpinia coriaria*).

One of the plants introduced in 1870 is still growing in the Gardens. I have not observed any others about Brisbane.

CANAIGRE (*Rumex hymenocephalus*).

Introduced and distributed by the Department of Agriculture in 1890.

TIMBER.

Very few exotic timber trees have been tried, and those introduced have been used for shade purposes, for, as is well-known, timber suitable for almost any kind of work requiring this material abounds within our State.

The following trees were introduced by the Brisbane Botanic Gardens :—

TEAK (*Tectona grandis*),
India, in 1856, and distributed in 1875.

REDWOOD (*Sequoia gigantea*),
California, in 1859. One of the original plants still standing, but has not made good growth.

BRITISH OAK (*Quercus pedunculata*),
In 1855. One of the original plants has now formed a handsome specimen in the Gardens.

ROSEWOOD (*Jacaranda mimosaefolia*),
Brazil, in 1856, and has since become a favourite subject for planting for shade and flowering purposes.

DEODAR CEDAR (*Cedrus Deodara*),
India, in 1861.

BLACK WALNUT (*Juglans nigra*),
North America, in 1855, and plants distributed in 1875.

WEYMOUTH PINE (*Pinus Strobus*),
North America, in 1858.

PENCIL CEDAR (*Juniperus Bermudiana*),
Bermuda, in 1863.

HUON PINE (*Dacrydium Franklini*),
Tasmania, in 1863.

KAURI PINE (*Agathis australis*),
New Zealand, in 1863.

BLACKWOOD (*Dalbergia latifolia*),
India, in 1868.

LOCUST TREE (*Hymenaea Courbaril*),
West Indies, in 1863. One of the original plants has formed a fine specimen in the Gardens.

SATINWOOD (*Chloroxylon Swietenia*),
India, in 1867. One of those originally planted has formed a fine tree in the Gardens.

MAHOGANY (*Swietenia Mahogani*),
West Indies, in 1870, and again in 1907, and seed distributed to localities from Maryborough to Cooktown in 1887.

EBONY (*Diospyros Ebenum*),
Sumatra, in 1870.

LIGNUM VITAE (*Guiacum officinale*),
West Indies, in 1871.

TOBACCO.

TOBACCO (*Nicotiana Tabacum*).

Many of the squatters of the early days grew tobacco for the sake of the dried leaf, which they used in the preparation of a sheep dip. Exhibits of prepared leaf were made at the International Exhibition, London, in 1862, by the Brisbane Botanic Gardens, and M. Thozet, of Rockhampton. Ten varieties were under trial at the Brisbane Botanic Gardens in 1870, and 400 packets of seed were distributed in 1873, and 15 varieties in 1876. In 1876, the Acclimatisation Society distributed seed of the varieties "Maryland," "Latakia," and "Virginia." Since then, other varieties have been distributed by the Botanic Gardens, the Acclimatisation Society, and the Department of Agriculture. The produce of dried leaf in 1908 was 5389 cwt. obtained from 669 acres.

SUGAR.

SUGAR (*Saccharum officinarum*).

We have records of sugar cane having been grown as far back as 1828, when it was used as a fence round the vegetable gardens attached to the penal settlement at Brisbane. Backhouse and Walker observed it being used for the same purpose in 1836. It was not until the year 1862 that any sugar was manufactured, and then only on a very small scale by Mr. Buhot, from canes obtained from the Brisbane Botanic Gardens. During this year the Hon. Louis Hope, of Ormiston, had the largest area under cultivation, viz., 20 acres, and 2,000 cuttings were distributed from the Brisbane Botanic Gardens. During the seventies, a nursery was established at Oxley by the Government, and 78 varieties were represented there in 1879. A distribution of 42 varieties was made in 1882 to 70 applicants, the weight of canes sent out amounting to 40 tons. About the year 1863, the Acclimatisation Society introduced some of the best

varieties then growing at Mauritius, and subsequently distributed various kinds of canes. In 1878, the Society entered into an exchange of canes with the Southern United States of America. Several importations have been made by the Department of Agriculture, notably some good varieties from New Guinea and Mauritius in the early nineties. Official returns show that in 1867 the 6 sugar mills then in existence produced 168 tons of sugar, and 13,100 gallons of molasses, while in 1907, 48 mills produced 188,307 tons of sugar, and 5,980,433 gallons of molasses were obtained in 1908.

BEVERAGES.

ARABIAN COFFEE (*Coffea arabica*).

Backhouse and Walker record having seen a few strong coffee plants near Brisbane in 1836. In 1862, a plantation was formed in the Brisbane Botanic Gardens, the plants having been raised from seed obtained from plants growing in Captain Wickham's garden, at Newstead, in 1858. In the year 1873, 6,400 plants were sent out from the gardens, and in 1882, there were 5,000 distributed. The Acclimatisation Society, which, by the way also distributed plants at the same time, introduced the variety "Mocha" in 1880. In 1908, 285 acres under cultivation produced 116,293lbs. of parchment coffee.

LIBERIAN COFFEE (*Coffea liberica*).

This species, which came with a great reputation from other coffee-growing countries, in the year 1882, was distributed from the Brisbane Botanic Gardens and Bowen Park, but has not come up to expectations in this State.

TEA (*Camellia theifera*).

Introduced by the Brisbane Botanic Gardens prior to 1861, and 1,000 plants distributed from there in 1862, 2,000 in 1873. Early in 1880, 3,500 plants were ready for distribution, in addition to 200 plants of the Assam variety, and there was a distribution in 1888. So far, these efforts have not resulted in any of this commodity being placed on the market.

TEA, PARAGUAY, or MATE (*Ilex paraguayensis*),

Introduced by the Brisbane Botanic Gardens prior

to 1861, but as its product did not meet with the taste of Queenslanders, it has not been grown otherwise than for shade purposes.

COCOA (*Theobroma Cacao*).

Plants were introduced by the Brisbane Botanic Gardens and Acclimatisation Society in 1866, and were distributed by the Society in the same year, and also in 1872 and 1883, and by the Botanic Gardens in 1874. A plant (under glass) fruited at Bowen Park in 1885. I saw a fine plant in fruit at Hambledon, near Cairns, in 1899, and was informed that it had been received from the Acclimatisation Society.

COLA NUT (*Cola acuminata*).

Introduced by the Department of Agriculture in the early nineties, and sent to the State Nursery at Kamerunga.

CHICORY (*Cichorum intybus*).

Grown by G. Grimes, at Coomera, in the seventies, and at Kamerunga State Nursery in 1890.

HOP PLANT (*Humulus lupulus*).

During the year 1883 experiments were made with the Hop plant at the Brisbane Botanic Gardens. The results were exceedingly good, the crop being equal to 10 cwt. per acre. It is said that in England 4 cwt. per acre for the first year is a good return. During James Pink's time (1885), 1,000 sets were imported by the Gardens, and distributed to farmers on the Downs. Another trial to start the industry was made in 1889, when the Department of Agriculture imported a number of sets from Victoria, and distributed them to farmers in the Killarney district.

FARINAS AND CEREALS.

ARROWROOT.

Both kinds of Arrowroot, viz., the White (*Maranta arundinacea*) and the Purple (*Canna edulis*) were introduced and distributed by the Brisbane Botanic Gardens about 1861. The latter species is recorded as having been grown near Ipswich, in 1844. The The purple variety has for many years been extensively cultivated in South Queensland, 480,620lbs. of commercial arrowroot having been produced in 1908. The recipients in the early distribution of the

Maranta evidently did not carry on the work of growing it commercially, for we find that the Department of Agriculture found it necessary to import it again when the Kamerunga State Nursery was formed about twenty years ago.

CASSAVA (*Manihot Aipi*, the Sweet, and *M. utilissima*, the Bitter).

J. Archer presented plants to the Brisbane Botanic Gardens in 1864, and they were growing at Bowen Park in 1866.

WHEAT (*Triticum vulgare*).

In the year 1828 there was an area under this crop at Ipswich, and in the year 1856, Mr. Childs had a good crop from about 50 acres at Bulimba. In the year 1859, M. Thozet obtained some seed from wheat-straw found floating in the Fitzroy River, and cultivated some excellent wheat from it near Rockhampton. For several years prior to 1862, J. Fleming and a few others cultivated wheat near Ipswich. It was well on in the fifties before wheat was grown on the Downs, and according to a record of 1862, "At Warwick, a flour-mill to be driven by steam power is in course of erection." In 1877, the Acclimatisation Society distributed several varieties of Mexican wheats received from Angas Mackay, and in 1880 introduced a number of Indian varieties on the suggestion of Dr. Joseph Bancroft. Since 1889 the Department of Agriculture has made frequent importations of new varieties. The average area under cultivation for the ten years ended 1908 was 90,729 acres, and the average production 1,223,599 bushels.

MAIZE (*Zea Mays*).

Maize has always been our principal cereal crop, and was one of the earliest grown, for we find that about 1827 there was a good area under cultivation at the penal settlements about New Farm, Bulimba, and also at Ipswich in 1828. In 1867, a trial was made at the Brisbane Botanic Gardens with a large number of imported varieties, but none equalled those already growing in the Colony. The Department of Agriculture, since 1889, has made

frequent importations of the best varieties obtainable from maize-growing countries. The produce in 1908 from 127,655 acres was 2,767,600 bushels.

RICE (*Oryza sativa*).

Rice was growing in the Brisbane Botanic Gardens and in the garden of the Hon. Louis Hope, at Cleveland, in 1861. In 1878, 3 cwt. in 17 varieties was imported by the Brisbane Botanic Gardens from India. The Acclimatisation Society grew some good samples in 1871, and distributed seed, and during the early nineties, the Department of Agriculture made several importations of seed. The area under cultivation in 1908 was only 7 acres against 319 acres in 1899.

BARLEY (*Hordeum vulgare*).

Samples of barley grown by M. Thozet, at Rockhampton, were exhibited at the International Exhibition, London, in 1862.

BUCKWHEAT (*Fagopyrum esculentum*).

Introduced by Acclimatisation Society in 1867.

CANARY SEED (*Phalaris canariensis*).

Has been growing on the Darling Downs during the past twenty years.

FRUITS.

APPLE (*Pyrus Malus*).

Collections were introduced by the Acclimatisation Society in 1868, 1869 and 1870. In 1871, J. G. Cribb presented a collection of American apples to the Brisbane Botanic Gardens. The area in bearing in 1908 was 390 acres, and the production 31,121 bushels.

PEAR (*Pyrus communis*).

Dr. Lang observed trees growing at Brisbane in 1845. A collection of American varieties was presented to the Brisbane Botanic Gardens by J. G. Cribb. 1,730 bushels of fruit were produced from 41 acres in 1908.

PEACH (*Prunus persica*).

Trees of this fruit were seen near Brisbane by Dr. Lang in 1845, and were growing in the Brisbane Botanic Gardens prior to 1865. In 1871, J. G. Cribb donated a collection of American varieties to the Brisbane Botanic Gardens, and the Gardens introduced

four Chinese varieties in 1876. 26,563 bushels of fruit were produced from 444 acres in 1908.

ALLIGATOR PEAR (*Persia gratissima*).

Sent by Sydney Botanic Gardens in 1854 to M. C, O'Connell, Port Curtis, and to a gardener in Brisbane, and was growing in the Brisbane Botanic Gardens, and three plants were distributed from there in 1862. Fruited for the first time in 1867. Plants were introduced from the Mauritius by the Acclimatisation Society in 1867. So far as I am aware, the only fruiting plant growing about Brisbane is in W. H. Parker's garden at Enoggera.

AVERRHOA CARAMBOLA.

Introduced by the Acclimatisation Society in the eighties.

BLACKBERRY (*Rubus fruticosus*).

J. G. Cribb introduced several American varieties from America during the seventies, one of the most fruitful being Lawton's Blackberry.

BANANA (*Musa spp.*)

Backhouse records having seen bananas growing at Brisbane in 1836. In 1856, Captain Wickham had the Cavendish (*M. Cavendishi*) and the Sugar Banana (*M. sapientum, var.*) growing at Newstead, and eight varieties, including the two mentioned, were growing in the Brisbane Botanic Gardens in 1861. The Acclimatisation Society from the first also interested itself in the introduction of good varieties, notably, nine from Singapore, in 1874, and several from Fiji, in 1875. Since its inauguration in 1888, the Department of Agriculture has been active in securing good varieties from countries where this fruit is successfully grown. During the year 1908, the produce from 4,647 acres under cultivation amounted to 1,651,163 bunches.

BREADFRUIT (*Artocarpus incisa*).

Introduced by the Brisbane Botanic Gardens at the end of the fifties. In 1860, Hon. H. Hood presented plants to the gardens, and plants were distributed from there and from Bowen Park on quite a number of occasions during the sixties and seventies. Plants introduced from Fiji were distributed by the Depart-

ment of Agriculture in 1892. I saw a plant in fruit at the Botanic Gardens, Townsville, in 1899.

JACK OR JACA FRUIT (*Artocarpus integrifolia*).

Introduced from India by the Brisbane Botanic Gardens in 1856.

CHINA QUINCE (*Cydonia sinensis*).

Plants received by F. M. Bailey from South Australia, and distributed in 1866, and plants worked from these were presented to the Acclimatisation Society in 1870 by C. W. Jarrott.

CHERRY (*Prunus Cerasus*)

Several varieties have been cultivated in the Stanthorpe District during the past twenty years.

CHINESE RAISIN (*Hovenia dulcis*).

Introduced by J. C Bidwill in 1850. Was growing in Captain Wickham's garden, Newstead, in 1856, and in the Brisbane Botanic Gardens in 1861.

ORANGE (*Citrus aurantium*).

Dr. Lang records having seen oranges growing at Brisbane in 1845. They were grown by Captain Wickham, at Newstead, in 1856. Ten varieties were represented in the Brisbane Botanic Gardens in 1861, those doing best being St. Michael, Mandarin, Bahia, Siletta, Blood and Parramatta. Forty-six varieties were growing in the Gardens in 1870. The Bahia Navel and Jaffa varieties were introduced by the Department of Agriculture in 1888. In 1908, 440,312 bushels of fruit were produced on 3,121 acres.

LEMONS (*C. medica var. limonum*); CITRONS (*C. medica*), and SHADDOCKS (*C. decumana*)

Were seen by Backhouse and Walker in 1836, and Lemons, Citrons, and Limes (*C. medica var. limetta*) were growing in the Botanic Gardens prior to 1870. 4,366 bushels of lemons were produced from 47 acres in 1908.

POMELO (*C. decumana var.*) was growing at Bowen Park in 1866.

CUSTARD APPLES (*Anona spp.*)

A. squamosa (*Sweet Sop*).

Plants were sent to M. C. O'Connell, Port Curtis, and to a gardener in Brisbane, in 1854, from the Sydney

Botanic Gardens. Growing in Captain Wickham's garden, at Newstead, in 1856, and in the Brisbane Botanic Gardens in 1861.

A. muricata (*Sour Sop*), and *C. Cherimolia* (*Cherimoyer*). Growing in Captain Wickham's garden in 1856, and at the Brisbane Botanic Gardens in 1861. The last-mentioned fruited at the Gardens for the first time in 1867.

A. reticulata (*Bullock's Heart*).

Growing at Bowen Bark in 1866.

Thirty-four custard apples were distributed from the Brisbane Botanic Gardens in 1862, but the species are not recorded. 557 bushels of custard apples were produced from thirteen acres in 1908.

DATE (*Phœnix dactylifera*).

Growing in Captain Wickham's garden, at Newstead, in 1856, and in the Brisbane Botanic Gardens in 1867. Some years ago the Acclimatisation Society distributed plants of good varieties to some western localities, and good fruit has recently been received in Brisbane from some plants growing near Charleville. The first plantation was one formed by Mr. Barnes, at Mackay, prior to 1868.

DURIAN (*Durio Zibethinus*).

Received by M. C. O'Connell, Port Curtis, and a gardener in Brisbane in 1854, from the Sydney Botanic Gardens, and introduced by the Brisbane Botanic Gardens and Acclimatisation Society in 1867. Distributed in that year, and also in 1874, but has not thriven for the same reason as that given in the case of the Mangosteen.

FIG (*Ficus carica*).

The following varieties were growing in the Brisbane Botanic Gardens in 1871, viz.:—Smyrna, Black, Brown and Green Ischia. Several other varieties have been introduced by the Department of Agriculture since 1888. 741 bushels of fruit were produced from ten acres in 1908.

GRAPE, CURRANT AND RAISIN (*Vitis vinifera*).

Backhouse and Walker saw grapes growing near Brisbane in 1836. In 1856, Captain Wickham had vines growing at Newstead, and twenty varieties

were to be seen in the Brisbane Botanic Gardens in 1861, those doing best being the varieties Black Hamburgh, Black Prince, White Sweetwater, Wantage, Xeres, and Muscatel Gordo Blanco. In 1871, a number of wine-producing varieties were introduced from South Australia, and in the same year J. G. Cribb presented the Gardens with thirty European and thirty American varieties: the latter were distributed to growers in Toowoomba, Warwick and Stanthorpe a year or two afterwards. In 1908, the area under vines was 1,554 acres which produced 4,229,980lbs. of fruit: 77,698 gallons of wine made,: and 619 gallons of brandy distilled. In 1865, thirty plants of the Zante currant were received from Victoria by the Acclimatisation Society, and in the same year, F. M. Bailey presented 300 cuttings of this variety to the Society, 200 of which were at once distributed. In 1871, the Sultana raisin was growing in the Brisbane Botanic Gardens, and in 1892 and 1893, forty thousand cuttings of raisin and currant grapes were distributed by the Department of Agriculture.

GUAVA (*Psidium spp.*)

Recorded by Backhouse as growing in Brisbane in 1836, but kinds not stated. *P. Cattleyanum*, the Strawberry Guava; *P. Guava*, the Apple Guava: and *P. littorale*, the Gooseberry Guava, were growing in the Brisbane Botanic Gardens in 1861.

JUJUBE (*Zizyphus jujuba*).

Growing in the Brisbane Botanic Gardens in 1864, and distributed to growers in the North, where it has taken such a hold of the lands in some localities as to be regarded as quite a nuisance.

KEI APPLE (*Aberia Caffra*).

Introduced and distributed by the Acclimatisation Society in 1876. My grandfather probably was the first to introduce this plant into Australia, he having taken plants to South Australia in 1839.

LITCHI (*Nephelium Litchi*).

M. C. O'Connell, Port Curtis, and a gardener in Brisbane, each received a plant from the Sydney Botanic Gardens in 1854, and it was represented in Captain Wickham's garden, at Newstead, and in the Brisbane

Botanic Gardens at the end of the fifties. The tree now in the Gardens fruits regularly. Another species of this genus, viz., *N. Longana*, the Longan, was also received by the same recipients above-mentioned from the Sydney Botanic Gardens in 1854. It was in the Brisbane Botanic Gardens in 1861, but is a far inferior fruit to that of its ally, the Litchi.

LOQUAT (*Photinia japonica*).

Growing at Bowen Park in 1866.

MANGO (*Mangifera indica*).

The Mango, which has become one of the most common fruits along the whole coast line of Queensland, is said to have been introduced by J. C. Bidwill at the end of the forties. Plants were sent from the Sydney Botanic Gardens in 1854 to M. C. O'Connell, at Port Curtis, and to a gardener in Brisbane. A plant was growing in the Brisbane Botanic Gardens in 1861, and fruited for the first time in 1867, and four plants were distributed from there in 1862, and also a number of grafted plants to likely growers in the North in 1883. The well-known varieties Alphonse and Raspberry were introduced from Bombay by the Acclimatisation Society in 1869, and the first-mentioned with the varieties Strawberry and Goa by the Botanic Gardens about the same time. Since then importations have been made by the institutions named, the Department of Agriculture, and privately. The production of fruit in 1908 was nearly 100,000 bushels. Crops from private gardens, however, are not included in this total.

MANGOSTEEN (*Garcinia mangostana*).

M. C. O'Connell, of Port Curtis, and a gardener in Brisbane received plants of this fruit, which is described as the most delicious in existence, from the Sydney Botanic Gardens in 1854. Although it has since been distributed on numerous occasions by the Brisbane Botanic Gardens and the Acclimatisation Society, so far has not met with success, owing no doubt to the intense humidity required for perfecting its growth not being obtainable even in our northern localities. Several other species of the genus have been introduced and have fruited here, but their fruits have been of a very inferior quality.

MONSTERA DELICIOSA.

Introduced by the Acclimatisation Society in 1874, and fruited in 1876.

PAPAW (*Carica papaya*).

Growing in the Brisbane Botanic Gardens in 1861. Since then good varieties have been frequently introduced by the Gardens, the Acclimatisation Society and the Department of Agriculture. 9,845 doz. fruit from 55 acres was the production in 1908.

PASSION FRUIT (*Passiflora edulis*) and the

GRANADILLA (P. *quadrangularis*)

Were growing in the Brisbane Botanic Gardens in 1861.

PERSIMMON (*Diospyros kaki*).

Growing in Captain Wickham's garden, at Newstead, in 1856, and in the Brisbane Botanic Gardens and Bowen Park in 1865. In 1875, the Acclimatisation Society imported ten varieties, and in 1889, the Department of Agriculture twenty varieties, from Japan. In 1908, seventeen acres produced 670 bushels of fruit.

PINEAPPLE (*Ananas sativa*).

Backhouse records having seen pineapples growing at Brisbane in 1836. They were grown by Captain Wickham, at Newstead, in 1856, and in 1861, twelve varieties were represented in the Brisbane Botanic Gardens, those doing best being Cayenne, Enville, Black Jamaica, Queen, Ripley Queen, and Moscow Queen. Good varieties have also been introduced from time to time by the Acclimatisation Society, James Pink and others. The 2,171 acres under cultivation produced 598,794 dozen fruit in 1908.

ROSE APPLE (*Eugenia jambos*).

Introduced by the Brisbane Botanic Gardens prior to 1861, and growing at Bowen Park in 1866. Another species of *Eugenia*, viz., *E. uniflora*, the Brazilian Cherry, was growing at Bowen Park in 1869.

ROSELLA (*Hibiscus sabdariffa*).

Growing in the Brisbane Botanic Gardens in 1875.

SAPODILLA PLUM (*Achras sapota*).

Growing at the Brisbane Botanic Gardens in 1861, and distributed in 1875.

STAR APPLE (*Chrysophyllum Cainito*).

Sent by Sydney Botanic Gardens to M. C. O'Connell, Port Curtis, and to a gardener in Brisbane, in 1854, and was growing at the Brisbane Botanic Gardens in 1861.

STRAWBERRY (*Fragaria vesca*).

Early in the seventies the Brisbane Botanic Gardens experimented with about a dozen varieties of strawberry, two of which are now extensively grown in South Queensland, viz., Marguerite and Trollop's Victoria. The production from 157 acres was 338,903 quarts in 1908.

TAMARIND (*Tamarindus indica*).

Plants sent by the Sydney Botanic Gardens in 1854 to M. C. O'Connell, Port Curtis, and to a gardener in Brisbane. Grown by Captain Wickham, at Newstead, in 1856, and also at the Brisbane Botanic Gardens in 1861. Twenty plants were distributed from the Gardens in 1862.

VI-APPLE (*Spondias dulcis*).

Introduced by Acclimatisation Society in 1876. Growing at Kamerunga State Nursery in 1891.

GREEN MANURES.

COWPEA (*Vigna sinensis*).

Introduced by the Department of Agriculture in the early nineties.

VELVET BEAN (*Mucuna pruriens var.*).

Was introduced in the early nineties by the Department of Agriculture and Colonial Sugar Refining Co.

PROCEEDINGS

OF THE

Annual Meeting of Members,

HELD ON JANUARY 29th, 1909.

The Annual Meeting was held at the Technical College, Ann Street, on January 29th, 1909.

The President (J. C. Brünnich, F.I.C., F.C.S., occupied the chair.

Minutes of last Annual Meeting were read and confirmed.

The Report of Council and Financial Statement for 1908 were read and adopted.

To the Members of the Royal Society of Queensland.

The Council of the Royal Society of Queensland have pleasure in presenting the Annual Report for the year ending 31st December, 1908.

Nine ordinary meetings were held during the year, when the following papers were read :—

March 26th.—" The Jardine Expedition from Rockhampton to Cape York, 1864," *Hon. A. Norton, M.L.C.*

" Recent Results of Astronomical Photography," *W. F. Gale, F.R.A.S.*

April 24th.—" The Origin of Australia," *Professor S. B. J. Skertchly.*

May 30th.—" Nature Studies in Queensland, New South Wales, and Fiji," *Hon. A. Norton.*

" Men of Colour—Women also," " Three Colour Pictures," *W. Saville Kent.*

June 26th.—" The People of New Georgia," *Rev. J. Goldie.*

August 1st.—" Palms of the Brisbane Botanical Gardens," *J. F. Bailey.*

August 29th.—" Geology of Tambourine Mountains," *J. Shirley, B. Sc.*

September 25th.—" Brisbane Tertiaries," *Professor S. B. J. Shertchly.*

October 31st.—"Queensland Grasses," *Dr. A. Sutton.*

November 28th.—"Chillagoe Garnet Rocks," *F. E. Connah.*
"Notes on Brisbane Pond Life," *W. R. Colledge.*

A special meeting was also held on March 23th, at which Mr. W. F. Gale, F.R.A.S., gave a lecture entitled "Astronomy and Photography."

The Council greatly regrets to have to report the death of four prominent members:—Messrs. L. A. Bernays, C.M.G., W. Saville Kent, W. Collins, and Hon. John Leahy.

Eight new members were elected and thirteen resigned or left, leaving the membership at 103.

The following names are those of the new members elected since the last report for 1907: Messrs. S. Dodd, F.R.C.V.S., D. Eglinton, Miss Eglinton, Messrs. E. H. Gurney, E. R. Gore Jones, G. Tucker, M.R.C.V.S., C. T. White, Major J. Johnston.

Ten Council meetings were held during the year, and the attendance of Councillors was as follows:—J. F. Bailey, 8; W. J. Byram, 4; J. C. Brünnich, 9; H. M. Challinor, 8; E. H. Gurney, 6; J. B. Henderson, 7; Hon. A. Norton, 9; J. Shirley, 1; F. Smith, 2; Dr. A. Sutton, 4; Dr. J. Thomson, 4.

Mr. C. T. White was appointed Hon. Librarian in succession to Mr. Frank Smith, who resigned; and Mr. H. M. Challinor having resigned from the position of Hon. Secretary, Mr. E. H. Gurney was appointed to the position.

During the year, upon the recommendation of the Library Sub-Committee, the Library has been put in order, being classified and catalogued by Mr. and Miss Eglinton.

The financial statement, which is hereto annexed, shews that the monetary affairs of the Society are on a sound basis.

Signed on behalf of the Council,—

J. C. BRÜNNICH,
President.

E. H. GURNEY,
Hon. Secretary.

Brisbane, January, 29th, 1909.

THE ROYAL SOCIETY OF QUEENSLAND.

FINANCIAL STATEMENT for Year Ending 31st December, 1908.

Dr. | Cr.

Receipts.	£	s.	d.	Disbursements.	£	s.	d.
To Balance from last report	12	16	7½	By Rent of Rooms	12	0	0
,, Subscriptions	87	14	3	,, Printing Proceedings	47	3	7
				,, International Catalogue	4	6	5
				,, Insurance on Library	1	2	6
				,, Subscription to British Science Guild ..	1	1	0
				,, Advertising	2	11	6
				,, Bank Charges and Cheque Book	0	12	6
				,, Commission to Collector	2	12	6
				,, Typing	0	15	11
				,, Library Register	2	5	6
				,, Stationery	3	13	6
				,, Freight	0	6	2
				,, Labour	0	5	0
				,, Petty Cash and Postage..	12	12	3½
				,, Balance to Credit	9	2	6
	£100	10	10½		£100	10	10½

Examined and found correct.

GEO. WATKINS, *Hon. Auditor.*

31st December, 1908.

A. NORTON, *Hon. Treasurer.*

Mr. Brünnich read his Presidential Address, entitled, "The Land we Live on," and was accorded a hearty vote of thanks by the meeting.

The following office-bearers for 1909 were then elected :— *President:* J. F. Bailey; *Vice-President:* Dr. Alfred Sutton; *Hon. Treasurer:* J. C. Brünnich, F.I.C.; *Hon. Secretary:* E. H. Gurney; *Hon. Librarian:* C. T. White; *Members of Council:* Colonel John Thomson, M.B., P.M.O., J. Brownlie Henderson, F.I.C., J. Shirley, B.Sc., H. Wasteneys, W. R. Colledge: *Hon. Auditor:* Geo. Watkins; *Hon. Lanternist:* A. G. Jackson.

LIST OF MEMBERS.

Archer, R. S.
Badger, J. S.
Bailey, J. F. (Life)
Bailey, F. M. (Life)
Bennett, F.
Bernays, L. A., C.M.G.
Brünnich, J. C., F.I.C.
Bundock, C. W.
Bundock, Miss Alice
Byram, W. J.
Cameron, J., M.L.A. (Life)
Cameron, W. E.
Carter, Hon. A. J., M.L.C.
Challinor, H. M.
Colledge, W. R.
Collins, J. C.
Collins, R. M.
Collins, Wm.
Collins, Miss Jane
Connah, Frank E.
Cooper, Sir Pope A., C.J.
Cory, A. H., M.R.C.V.S.L.
Costin, C. W.
Dodd, S., F.R.C.V.S.L.
Dunstan, Benjamin
Eglinton, D.
Eglinton, Miss
Forrest, Hon. E. B., M.L.A.
Fox, Geo., M.L.A.
Gailey, R. (Life)
Gibson, Hon. A., M.L.C.
Gore, Gerard R.
Gore-Jones, E. R.
Gray, Hon. G. W., M.L.C.
Greenfield, A. P.
Griffith, Sir S. W. (Life)
Gurney, E. H.
Hedley, C.
Henderson, J. B., F.I.C.
Henderson, Mrs. J. B.
Hirschfeld, Dr.
Hockings, P. F.
Hogarth, Mrs.
Holland C. W.
Hood, W. W.
Hopkins, Dr.
Illidge, T.
Illidge, Rowland
Irving, J., M.R.C.V.S.L.
Jack, Dr. R. L. (Life)
Jackson, A. G.
Johnston, Major J.
Jones, P. W.
Jones, A. Raymond
Kent, W., Saville (Life)
Leahy, P. J., M.L.A.
Leahy, John, M.L.A.
Lord, Frederick
Love, Dr. W.
Lucas, Dr.
Marks, Hon. Dr.
Marks, E. O.
May, Dr.
McCall, T.
McConnel, Eric W.
McConnel, James H.
McConnel, Edward J.
MacKie, R. Cliffe
Miles, Hon. E. D., M.L.C.
Millar, T. W.
Murray-Prior, Mrs.
Norton, Hon. Albert (Life)
Parker, W. R., L.D.S.
Plant, Lieut.-Col. C. F.
Plant, Hon. E. H. T., M.L.C.
Pound, C. J.
Power, Hon. F. I., M.L.C.
Pritchard, C.
Raff, Hon. Alex. (Life)
Reid, Major D. E.
Roe, R. H., M.A. (Life)
Ryan, Dr. J. P.
Sankey, Major J. R.
Schneider, Henry (Life)
Shirley, J., B.Sc.
Smith, Frank, B.Sc.
Stevens, Hon. E. J. (Life)
Steele, T. F.L.S., F.E.S. (Life)
Sutton, Dr. A.
Sutton, J. W. (Life)
Taylor, Hon. Dr.
Thomson, Dr. John (Life)
Thynne, Hon. A. J.
Tonks, T.
Townley, Capt. W.
Tucker, G., M.R C.V.S.L.
Turner, Dr. A. Jefferis
Walsh, Rev. W. M. (Life)
Wasteneys, H.
Watkins, Geo.
Weedon, Warren (Life)
White, C. T.
Willcocks, G. C.
Zoeller, C.

Printed for the Society by
H. POLE & Co., Elizabeth Street, Brisbane.

PROCEEDINGS

OF THE

Annual Meeting of Members,

Held on Saturday, February 26th, 1910.

The Annual Meeting was held in the Technical College, Ann Street, on February 26th, 1910.

The President (Mr. J. F. Bailey) occupied the chair.

The minutes of the last Annual Meeting were read and confirmed.

The Annual Report and Balance Sheet being handed to the members were then read and adopted.

To the Members of the Royal Society of Queensland.

Your Council have pleasure in submitting their Report for the year 1909.

Ordinary meetings have been held as in Appendix B.

Fourteen Council meetings were held during the year, at which the attendance was as shown in Appendix A.

Part I. of Vol. XXII. of our Proceedings has been published and issued.

The number of new members proposed during 1909 has scarcely been up to the usual mark, and we have been unfortunate in losing by death, removal, and other causes, a number of members. The deaths have included Dr. J. Thomson and Capt. Townley. In the case of Councillor and Past-President Dr. J. Thomson, a letter of condolence was forwarded to his family.

There are now on our roll 88 members ; 14 life members ; 73 ordinary members ; besides corresponding members, and 1 Associate member. See Appendix D.

Some difficulty has been experienced in getting original contributions for the monthly meetings. Many of our members who are best in a position to contribute original research papers and exhibits plead that their

published results are needed for their several Government scientific journals.

It is confidently expected, however, that the forthcoming University, with its bent towards scientific research, will increase our membership and our list of original papers.

In July, Professor Laby was welcomed by our Society, in conjunction with the South Brisbane Technical College. A trip to One-Tree Hill was organized, and the Professor lectured in the evening under the joint auspices in each case.

In November, Messrs. Henderson and Brünnich gave an exhibition of modern scientific chemical apparatus. A most enjoyable and educative meeting was the result.

The Library is rapidly growing, and is, in fact, too large for the new room to which it was shifted early in January, 1910. When funds permit, it will be well to bind such matter as is still unbound.

The Premier, during the year, took steps to facilitate the possibility of our joint occupancy of the room at present occupied by the Royal Geographical Society in the Public Library, but, as the Minister for Education (the Hon. W. H. Barnes) had just granted us a continued tenancy in the Technical College at a nominal rental, our Library to be open to the students under the supervision of the College Librarian, we decided to remain in our present quarters.

As will be seen by Appendix C, there is a satisfactory credit balance so far as the ordinary working expenses of the Society are concerned, but there still remains the binding of much of the matter in the Library when funds permit.

During the year the Hon. Secretary (Mr. E. H. Gurney) resigned, but was appointed to the Council. Mr. F. Bennett took his place as Hon. Secretary. The place of Dr. J. Thomson on the Council was filled by Mr. W. R. Parker, and Mr. Wasteneys was succeeded by Mr. Gurney.

F. BENNETT, *Hon. Secretary.* J. F. BAILEY, *President.*

Brisbane, February 26th, 1910.

APPENDIX A.

Office.	Name.	Council Meetg's.—12	Special Meet'gs.—2	—
President ..	J. F. Bailey	11	2	
Vice-President ..	Dr. A. Sutton	2	1	
Hon. Treasurer..	J. C. Brünnich, F.I.C. ..	6	1	
Hon. Secretary	E. H. Gurney	12	2	Resigned May
	F. Bennett	6	1	Appointed June
Hon. Librarian..	C. T. White	7	1	
Members of Council	J. B. Henderson, F.I.C...	7	2	
	J. Shirley, B.Sc... ..	1	0	
	W. R. Colledge	12	2	
	E. H. Gurney	See	above	Appointed June
	W. R. Parker, L.D.S. ..	3	0	Appointed July
	Dr. J. Thomson	0	0	Died
	H. Wasteneys	3	1	Left in May

APPENDIX B.

List of Papers Read During 1909.

No.	Date.	Title.	Author.
1	Jan. 29	The Land We Live On (Presidential Address)	J. C. Brünnich, F.I.C.
2	Feb. 27	Some Aspects of Savage Life ..	Rev. B. Danks.
3	Mar. 27	(1) Life History of the Filaria Mosquito	W. R. Colledge.
		(2) Effects and Methods of Eradication	A. Jefferis-Turner, M.D.
4	May 29	Queensland Vegetation (Lecture)	J. F. Bailey
5	July 3	Scientific Jottings in Remote Parts of Queensland	F. Bennett
6	July 10	The Atomic Theory of Chemistry (Lecture)	Prof. Laby.
7	Aug. 28	The Life History of a Mollusc (Lecture)	J. F. Shirley, B.Sc.
8	Sept. 25	Climates of the Geological Past	H. I. Jensen, D.Sc
9	Oct. 30	(1) Phosphatic Rocks and their Occurrence in Australia	H. I. Jensen, D.Sc.
		(2) Estimation of Zinc by means of Potassium Ferrocyanide	F. E. Connah.
		(3) Calculation of Percentages from Volumetric Work	F. E. Connah
10	Nov. 30	Exhibition of Modern Chemical Apparatus	J. B. Henderson, F.I.C. J. C. Brünnich, F.I.C.
		Notes on an Artesian Water Analysis	J. B. Henderson, F.I.C

APPENDIX C.

THE ROYAL SOCIETY OF QUEENSLAND.

FINANCIAL STATEMENT for the Year 1909.

Dr. | Cr.

Receipts.	£	s.	d.	Disbursements.	£	s.	d.
To Balance from last Report	9	2	6	By Printing	25	0	0
,, Subscriptions	65	12	0	,, Postage, Petty Cash. &c.	6	10	0
				,, Postage on Proceedings	2	0	0
				,, Receptions, Funerals, Address to the Governor	3	16	2
				,, Cataloguing Library	6	0	0
				,, Insurance on Library	1	2	6
				,, Freight	0	3	6
				,, Rent	6	0	0
				,, Caretaker	1	0	0
				,, Bank Charges	0	10	0
				,, Balance in Bank and in hand	22	12	4
	£74	14	6		£74	14	6

Examined and found correct,

GEO. WATKINS, *Hon. Auditor.*

J. C. BRÜNNICH, *Hon. Treasurer.*

Brisbane, 31st January, 1910.

APPENDIX D.

LIST OF MEMBERS.

ORDINARY MEMBERS.

Archer, R. S.
Badger, J. S.
Barton, E. C.
*†Bailey, F. M., F.L.S.
†Bailey, J. F.
Bennett, F.
Brünnich, J. C., F.I.C.
Bundock, Miss Alice
Bundock, C. W.
Byram, W. J.
Cameron, W. E., B.A.
Colledge, W. R.
Collins, Miss Jane
Collins, J. George
Collins, R. M.
Connah, F. E.
Cooper, Sir Pope A., C.J.
Costin, C. W.
Dempsey, J. J.
Dodd, S., F.R.C.V.S.L.
Dunstan, Benj.
Eglinton, Dudley
Eglinton, Miss Hilda
Forrest, E. B., M.L.A.
†Gailey, Richard
Gibson, Hon. A., M.L.C.
Gore-Jones, E. R.
Greenfield. A. P.
*†Griffith, Sir S. W.
Gurney, E. H.
Hedley, C., F.L.S.
Henderson, J.B., F.I.C.
Hirschfield, Eugen, M.D.
Holland C. W.
Hopkins, G., M.D.
Hunt, G. W.
Illidge, Rowland
Illidge, T.
Irving, J., M.R.C.V.S.L.
†Jack, R. L., L.L.D., F.G.S., F.R.G.S.
Jackson, A. G.
Jefferis-Turner, A., M.D.
Johnston, Jas.
Jones, P. W.
Leahy, P. J.
Lindsay, W.
Lord, F.
Love, Wilton, M.B.
Lucas, T. P., L.R.C.P.
His Excellency Sir William Macgregor, M.D., C.M.G.S. C.B., D.Sc., &c.
MacKie, R. Cliffe
Marks, Hon. C. F., M.D., M.L.C.
Marks, Edward O., B.A., B.E.
May, T. H., M.D.
Miles, Hon. E. D., M.L.C.
McCall, T., F.I.C.
McConnel, Eric W.
McConnel, E. J.
McConnel, J. H.
†Norton, Hon. A. M.L.C.
Parker, W. R., L.D.S.
Plant, C.F.
Plant, Hon. E. H. T., M,L.C.
Pound, C .J., F.R.M.S.
Pritchard, C.
Pulsford, F. E.
*Raff, Hon. Alex, M.L.C.
Rands, W. H., F.G.S.
Reid, D. E.
Riddell, R. M.
†Roe, R. H., M.A.
Ryan, J. P., M.D.
Sankey, J. R.
†Schneider, H., M.A.
Shirley, J., B.Sc.
Silcock, P.
Smith, F., B.Sc.
†Steele. T., F.L.S., F.E.S.
†Stevens, Hon. E. J., M.L.C.
Sutton, A., M.D.
†Sutton, J. W.
Taylor, Hon. W., M.D., M.L.C.
Thynne, Hon. A. J., M.L.C.
Tonks, T.
Watkins, G. C.
†Weedon, Warren
Willcocks, G. C.

ASSOCIATE MEMBER.

White, C. T.

*Members of Philosophical Society. †Life Members.

The President then delivered his address (illustrated by many fine slides) on the "Introduction of Economic Plants Into Queensland," and was accorded a hearty vote of thanks by the meeting.

The following office-bearers for 1910 were then elected :— Presidents W. R. Colledge; Hon. Treasurer, J. C. Brünnich, F.I.C.; Hon. Secretary, F. Bennett; Hon. Librarian, C. T. White; Members of Council: E. H. Gurney, J. B. Henderson, F.I.C., J. Shirley, B.Sc., W. R. Parker, L.D.S.

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND.

VOL. XXIII.

PART I.

PRINTED FOR THE SOCIETY
BY
H. POLE & Co., PRINTERS, GEORGE ST., BRISBANE.
1911.

THE

Royal Society of Queensland

Patron:

HIS EXCELLENCY SIR WILLIAM MACGREGOR,
M.D., G.C.M.G., C.B., D.Sc., ETC.

OFFICERS, 1911.

President:

J. BROWNLIE HENDERSON, F.I.C.

Vice-President:

P. L. WESTON, B.Sc., B.E.

Hon. Treasurer:

J. C. BRÜNNICH, F.I.C.

Hon. Secretary:

F. BENNETT.

Hon. Librarian:

C. T. WHITE.

Members of Council:

W. R. COLLEDGE. E. H. GURNEY.
H. RICHARDS, M.Sc.

Trustees:

JOHN CAMERON. HON. A. NORTON, M.L.C.
HON. A. J. THYNNE, M.L.C.

Hon. Auditor:

GEO. WATKINS.

Hon. Lanternist:

A. G. JACKSON.

CONTENTS.

THE

Royal Society of Queensland

Patron:
HIS EXCELLENCY SIR WILLIAM MACGREGOR,
M.D., G.C.M.G., C.B., Etc.

OFFICERS, 1912.

President:
P. L. WESTON, B.Sc., B.E.

Vice-President:
H. C RICHARDS, M Sc.

Hon. Treasurer.
J. C. BRÜNNICH, F.I.C.

Hon. Secretary:
F. BENNETT.

Hon. Librarian:
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CONTENTS.

ON NEW OR INSUFFICIENTLY DESCRIBED FISHES.

By J. DOUGLAS OGILBY.

Read before the Royal Society of Queensland, July 30th, 1910.

The following paper contains the descriptions of 2 new genera and 24 new species of fishes and of 10 species which either have not previously been recorded from Australian Seas or of which the original descriptions were insufficient or erroneous. Of the 34 species described, all but 7 belong to the Queensland Fauna, the exceptions being

Dobo, Aru Iss.	Croker Is., N.T.
Sphyræna altipinnis	*Hemipimelodus colcloughi*
Chœrodon vitta	*Brachirus aspilos*
Valenciennea aruensis	*Cynoglossus sindensis*
Coryzichthys guttulatus	

With the exception of 5, the types of the new species are in the A.F.A.Q.* Museum, these being *Xystodus banfieldi*, *Megaprotodon maculiceps*, *Brachirus salinarum*, and *B. breviceps* in the Queensland Museum, and *Spheroides squamicauda* in the collection of Mr. J. T. Jameson, of Woody Point.

The new genera here proposed are as follows :—

i. XYSTODUS ; fam. *Synodidæ*† ; type *X. banfieldi.*

ii. CHILIAS ; fam. *Pteropsaridæ* ; type *Percis stricticeps* De Vis.

The new species are :—

1. CARCHARIAS SPENCERI ; fam. *Carchariidæ* ; Brisbane River.

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* Amateur Fishermen's Association of Queensland.

† By Art. 4 of "The International Code of Zoological Nomenclature" we learn that "the name of a family is found by adding the ending *idæ* to the root of the name of its type genus." Plainly therefore the family name should be written as above, not *Synodontidæ*, as it is usually given. The same rule applies to all similar generic names ending in such Greek derivatives as odus, stoma, etc.

2. ANCHOVIA ÆSTUARIA; fam. *Engraulidæ*; Brisbane River.
3. XYSTODUS BANFIELDI; fam. *Synodidæ*; Dunk Island.
4. HEMIPIMELODUS COLCLOUGHI; fam. *Siluridæ*; Croker Island.
5. SPHYRÆNA ALTIPINNIS; fam. *Sphyrænidæ*; Aru Islands.
6. PRIOPIS OLIVACEUS; fam. *Ambassidæ*; Creeks round Brisbane.
7. PRIOPIS NIGRIPINNIS; fam. *Ambassidæ*; Creeks at Kilcoy.
8. CHŒRODON VITTA; fam. *Labridæ*; Aru Islands.
9. MEGAPROTODON MACULICEPS; fam. *Chætodidæ*; Moreton Bay.
10. TRIACANTHUS FALCANALIS; fam. *Triacanthidæ*; Moreton Bay.
11. SPHEROIDES SQUAMICAUDA; fam. *Tetraodidæ*; Moreton Bay.
12. DICOTYLICHTHYS MYERSI; fam. *Diodidæ*; Brisbane River.
13. CHILOMYCTERUS GRANDOCULIS; fam. *Diodidæ*; Moreton Bay.
14. VALENCIENNEA ARUENSIS; fam. *Gobiidæ*; Aru Islands.
15. RHINOGOBIUS LEFTWICHI; fam. *Gobiidæ*; Great Sandy Strait.
16. SCORPÆNOPSIS PALMERI; fam. *Scorpænidæ*; Moreton Bay.
17. SCORPÆNOPSIS MACROCHIR; fam. *Scorpænidæ*; Moreton Bay.
18. APISTUS BALNEARUM; fam. *Scorpænidæ*; Brisbane River.
19. EROSA FRATRUM; fam. *Scorpænidæ*; Moreton Bay.
20. EBISINUS PROCNE; fam. *Dactylopteridæ*; Moreton Bay.
21. BRACHIRUS SALINARUM; fam. *Soleidæ*; Kimberley, N.Q.
22. BRACHIRUS BREVICEPS; fam. *Soleidæ*; Rockhampton.
23. CORYZICHTHYS GUTTULATUS; fam. *Batrachoididæ*; Aru Islands.
24. CALLIONYMUS GROSSI; fam. *Callionymidæ*; Moreton Bay.

The redescribed species are:—

1. DECAPTERUS ? ECCLIPSIFER (De Vis); fam. *Carangidæ*; insufficiently described.
2. BUTIS LONGICAUDA (De Vis); fam. *Gobiidæ*; insufficiently described.

3. AMBLYGOBIUS GOBIOIDES (Ogilby)=*Gobius cristatus* Macleay; fam. *Gobiidæ*; description insufficient.
4. BRACHIRUS ASPILOS (Bleeker); fam. *Soleidæ*; new to Australia.
5. CYNOGLOSSUS SINDENSIS (Day); fam. *Soleidæ*; new to Australia.
6. CHILIAS STRICTICEPS (De Vis); fam. *Pteropsaridæ*; insufficiently described.
7. DACTYLOPUS DACTYLOPUS (Bennett); fam. *Callionymidæ*; new to Australia.
8. PETROSKIRTES FURTIVUS (De Vis); fam. *Blenniidæ*; descriptions insufficient.
9. PETROSKIRTES JAPONICUS (Bleeker); fam. *Blenniidæ*.
10. PETROSKIRTES ANOLIUS (Cuvier & Valenciennes); fam. *Blenniidæ*.

CARCHARIIDÆ.

CARCHARIAS SPENCERI sp. nov.

Depth of body 6·5, length of head 5·6, predorsal length 3.35, length of caudal 3·6 in length of body. Width of head 1·3, depth of head 1·55, length of snout (preoral length) 3, diameter of eye 11·5, width of interocular 1·6, of internasal 3, of mouth 2 in length of head.

Body robust; length of head 1·8 in that of the trunk. Snout short and blunt 1·8 in the space between the eye and the 1st gill-opening; inner angle of nostril nearer to the mouth than to the tip of the snout; ramal length of upper jaw 1·25, length of snout 1·5 in the width of the mouth. Tip of mandible rounded, extending forward to the vertical from the front margin of the eye; labial folds short, the upper sometimes absent. Teeth $\frac{12\text{-}1\text{-}12 \text{ or } 13\text{-}1\text{-}13}{12\text{-}1\text{-}12}$, erect and fully serrated in both jaws; those of the upper jaw triangular and without a trace of notch on the outer edge, of the lower much narrower with a broad evenly convex serrated base; a small smooth symphysial tooth in each jaw. Space between eye and snout 1·4 in its distance from the 1st gill-opening; interocular region convex. Head and trunk as long as the tail.

First dorsal inserted a little nearer to the pectoral than to the ventral, its anterior border slightly convex with the outer angle obtusely pointed; posterior angle produced and acute, not nearly reaching to the vertical

from the ventral; base of fin rather more than its vertical height. Second dorsal small, inserted a little nearer to the origin of the 1st than to the tip of the tail. Anal originating somewhat behind the 2nd doısal, its length 1·6 in its distance from the caudal, which is equal to that from the ventral. Caudal long with the upper angle obtusely pointed. Pectoral extending to below or beyond the end of the 1st dorsal, the anterior and posterior borders convex with more or less rounded angles, the outer border emarginate. Space between ventral and anal 1·75 in its distance from the pectoral.

Last gill-opening not much smaller than the 3rd, which is rather more than twice the eye-diameter.

Above ashy or lead blue, below white; tips of 2nd dorsal, caudal, and pectorals darker. (Named for my friend and colleague Adkins Robert Spencer, to whom I am indebted for the specimen above described).

Seas and estuaries of Eastern Australia, ascending rivers to, and it is said even beyond, the furthest limit of tidal influence, attaining a length of 2·5 mm. It is the common " blue shark " of the Brisbane River.

Described from a specimen 122 cm. long, the jaws of which are in the A.F.A.Q. collection; Cat. No. 290.

ENGRAULIDÆ.

ANCHOVIA ÆSTUARIA sp. nov.

D. 13 or 14; A. 31 to 34; P. 12; V. 7; Sc. 40 or 41—9 or 10. Depth of body 3·55, length of head 3·75, of maxillary 4, of anal fin 3·65, of caudal fin 3·75 in the length of the body. Length of snout 4·4, diameter of eye 4, width of interorbit 4, height of dorsal 1·4, depth of peduncle 2·4, length of pectoral 1·25, of ventral 2·35 in the length of the head.

Upper surface of head linear and oblique, with a well-marked fronto-occipital ridge, the nape anteriorly with a slight but distinct acclivity; snout vertically rounded in front and projecting beyond the lower jaw to a distance equaling three fourths of the diameter of the eye; inter-orbital region strongly convex. Premaxillary, maxillary, and mandible each with a series of minute teeth; tongue toothed. Maxillary extending slightly beyond the mandibulaı articulation. Scales thin and easily detached; ventral profile cultrate and rather strongly serrated.

Dorsal fin originating a little behind the ventral and one fifth nearer to the tip of the snout than to the root of the caudal, its length 1·55 in its height; outer border linear, the last ray not produced. Anterior rays of anal about thrice as long as the middle rays and 1·4 in the height of the dorsal. Middle caudal rays 2 in the lower and longer lobe. Pectoral fin long and pointed, extending to or slightly beyond the base of the ventral. Space between origin of ventral and tip of snout 1·45 in its distance from the root of the caudal.

Gill-rakers long and slender, 24 on the lower branch of the anterior arch, the longest 1·25 in the diameter of the eye. Vertebræ 42.

Pale green above; sides and belly silvery; usually a dusky shoulder spot. Longer dorsal rays and caudal lobes narrowly tipped with blackish.

Total length 150 millim.

Rivers of South-Eastern Queensland. Abundant in the Brisbane River, where it is taken commonly in the prawn nets, but is not used as food.

Described from numerous specimens measuring from 72 to 150 millimeters.

Allied to *A. nasuta* (Castelnau)* from the Norman River, Carpentaria, from which it may be distinguished by the following characters:—

Depth of body rather more than 3·00, length of head 4.50 in length of body; dorsal originating midway between tip of snout and base of caudal .. .. .. *nasuta*

Depth of body rather less than 3·50, length of head 3.75 in length of body; dorsal originating one fifth nearer to tip of snout than to base of caudal .. .. *æstuaria*

Type in the Museum of the A.F.A.Q.; Cat. No. 406.

SYNODIDÆ.

XYSTODUS† gen. nov.

Body depressed. No lateral line. Teeth in the jaws unequal and uniserial, consisting of long compressed widely separated sagittate fangs, having between each pair one or two much shorter obtusely pointed teeth; palatine teeth

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* *Engraulus nasutus* Castlenau, Proc. Linn. Soc. N.S. Wales, iii, 1879, p. 51.

† ξυστόν, a spear; ὀδούς, a tooth.

of equal size, acicular and biserial, forming a long narrow band; hyoid bones with two series of strong teeth; a multiserial patch anteriorly on the tongue. Nostrils well separated, the anterior circular and cirrigerous, the posterior an oblique slit below the level of the anterior. Eye rather small, the adipose lid rudimentary. Dorsal fin inserted midway between the tip of the snout and the root of the caudal; no adipose fin; anal fin similar to but longer than the dorsal; pectorals small and rounded; ventrals 8-rayed. Vent much nearer to the ventral than to the anal. Otherwise as in *Saurida*.

Coast of North Queensland (Dunk Island).

XYSTODUS BANFIELDI sp. nov.

D. 11; A. 14; P. 13; Sc. 51-13. Depth of body 7·2, length of head 3·6, of caudal fin 5·5 in length of body. Length of snout 4·25, diameter of eye 6·8, width of interorbit 8·5, cleft of mouth 1·6, height of dorsal 1·9, length of pectoral 2·25, of ventral 1·1 in length of head.

Body slender, a little wider than deep. Frontal groove smooth in front, profusely pierced by small pores behind, continuous with the occipital groove. Diameter of eye 1·6 in the length of the snout; adipose lid vestigial; interorbital region concave, its width 1·25 in the eye-diameter.

Dorsal fin nearly as high as long, the tip of the longest ray, when depressed, barely reaching to the base of the last. Anal fin originating midway between the root of the caudal and the origin of the ventral, about thrice as long as high, and one-fourth longer than the dorsal. Middle caudal rays 2·5 in the lower lobe; caudal peduncle as deep as wide, without trace of lateral ridge. Pectoral fin extends to above the end of the base of the ventral, which is inserted a little nearer to the anal than to the tip of the mandible and well in advance of the dorsal, the 6th ray longest, not reaching to the vent.

Lilac, each scale of the back with a dark median stripe, which is often forked distally and form together narrow longitudinal pencillings, of which there are about nine; a purplish lateral band about half a scale wide from the upper part of the opercle to the root of the caudal, dividing the lilac of the back from the yellowish white of the lower half of the body; anteriorly, to above the pectoral the band is black, and from its lower edge it throws

off twelve short subcruciform bars to enroach on the lighter color below; these bars are much larger and darker in front and gradually fade away behind. Head spotted with violet and with transverse dark-edged bands between the eyes and three similar bands directed forward and downward from the eye to and upon the premaxillary. Base and middle rays of caudal and base of pectoral yellow. (Named for Edward James Banfield, Honorary Government Ranger of Dunk Island and the neighboring islets, to whose acute observation Queensland science is greatly indebted for its knowledge of the biology of the district).

Described from a specimen in the Queensland Museum collected by Mr. Banfield, near Dunk Island, and measuring 142 millim.

SILURIDÆ.

HEMIPIMELODUS COLCLOUGHI sp. nov.

D. i 6, 0; A. 17; P. i 12. Depth of body 4·55, length of head 3·25, predorsal length 2·35, interdorsal space 3·4, upper caudal lobe 4·2 in length of body. Width of head 1·45, length of snout 2·5, diameter of eye 5·45, width of interorbit 2·9, length of maxillary barbel 1·25, of dorsal spine 1·65, of anal fin 2·25, of pectoral spine 1·8, of ventral fin 2 in length of head.

Upper profile of head linear and but little oblique; diameter of eye 2·2 in the snout, which is feebly rounded and one fourth wider than long; interorbital region gently convex, its width equal to that of the mouth. Premaxillary teeth in a continuous band, which is somewhat undulous posteriorly, pointed at the extremities, and nearly 4 times as long as wide; mandibular band divided mesially, of nearly equal width throughout, but narrowing rather abruptly to a point externally. Barbels slender, the maxillary extending to the origin of the pectoral fin; postmental barbel 1·5 in the maxillary barbel, inserted but little behind and outside the mental barbel, which scarcely reaches the gill-opening. Cranial shield mostly smooth, with a patch of small granules on either side, and a more crowded mesial patch posteriorly, from which two or three rapidly diminishing series extend forward along each side of the occipital groove. Nuchal shield sparsely granular anteriorly, with a well-marked median ridge, on either side of which is a lower and slightly divergent

ridge, its greatest width 1·4 in its length, which is 2·6 in its distance from the tip of the snout; outer border deeply, posterior feebly emarginate. Dorsal buckler moderate, saddle-shaped, smooth. Humeral process smooth and broadly triangular, terminating in an acute point, and extending along the proximal third of the pectoral spine.

Dorsal spine slender, serrated in front and behind, the sides striated; adipose fin moderate, inserted above the middle of the anal, one third higher than long, its base 1·65 in that of the rayed dorsal. Anal fin as high as long. with the outer border feebly emarginate. Least depth of caudal peduncle 2 in its length behind the adipose fin. Pectoral spine curved, similar to but more strongly serrated than that of the dorsal. Ventral fin obtusely pointed, not reaching to the anal. Vent a little nearer to the anal than to the ventral.

Gill-membranes meeting at a very obtuse angle, the free margin moderate; axillary pore minute.

Upper surface of body pale leaden blue, of head and nape brown, darkest on the latter; a bluish patch above the eye; cheeks, preorbitals, edges of mandibular rami, and humeral processes strongly tinged with yellow; lower surface of head lilac, of body bluish white. Dorsal fin pale blue, the basal portion and the spine gray; adipose fin with a narrow whitish border; lobes of caudal and bases of anal and ventrals yellow, the middle rays of the former and the tips of the two latter pale blue; pectorals pale blue, the spine gray. (Named for its discoverer, Mr. John Colclough).

Described from a specimen, measuring 202 millim., taken at Croker Island, N.T., and presented by its collector to the A.F.A.Q. Museum; Cat. No. 993.

SPHYRÆNIDÆ.

SPHYRÆNA ALTIPINNIS sp. nov.

D. v-i 9; P. 15: Sc. 13—128—24. Depth of body 7·15, of caudal peduncle 14·4, length of head, 3·2, of caudal fin 4·55, of pectoral 8·75, predorsal length 2·45 in length of body. Length of snout 2·15, diameter of eye 5·15, width of interorbit 6·85 in length of body.

Body robust, its width 1·4 in its depth. Depth of head subequal to the postorbital region; diameter of eye

2·4 in the snout; interorbital region feebly convex. Maxillary extending to below the anterior border of the eye, its distance from which is 3, its greatest width 2·2 in the eye-diameter; lower jaw without fleshy appendage. Premaxillary teeth about 54 on each ramus; posterior canine much the larger; 4 enlarged palatine teeth, the second the strongest; mandible with 9 lateral teeth, the canine sinistral. Opercle with a weak spine. Cheeks and opercles scaly; upper surface of head naked.

Dorsal fin originating well in advance of the tip of the appressed pectoral; dorsal spines flexible, the second the longest, 1·35 in the length of the snout; soft dorsal higher than the spinous, its last ray produced. Anal originating below the middle of, terminating well behind, and similar in size and shape to the soft dorsal. Middle caudal rays 3 in the upper and longer lobe; depth of peduncle one and one sixth time the diameter of the eye. Pectoral fin 1·25 in the length of the snout and extending well beyond the origin of the ventral. Ventral inserted below the origin of the spinous dorsal and midway between the tip of the mandible and the middle of the anal, its length 1·45 in the snout.

No elongate gill-raker.

Above purple, each of the scales with a light centre; sides silvery, crossed by fourteen vertical purple bars, the first behind the tip of the pectoral, the last above the end of the anal; lower surface pearly white; dorsal fins blackish; caudal grayish brown, darkest above; anal, ventrals, and pectorals gray, the anterior rays of the former and the outer rays of the two latter dusky.

Total length 405 millimeters.

Described from a single specimen obtained at the Aru Islands by Mr. John Colclough.

Type in the A.F.A.Q. Museum., Cat. No. 1066.

CARANGIDÆ.

DECAPTERUS ? ECCLIPSIFER (De Vis).*

D. viii, i 32 i; A. ii, i 28 i; P. 21: Sc. 124; L.l. 86. Depth of body 4·30, length of head 3·65, height of soft dorsal 8·90, of anal 9·30, length of pectoral 3·75 in

* *Caranx ecclipsifer* De Vis, Proc. Linn. Soc. N.S. Wales, ix, 1884, p. 541: Cape York.

length of body. Length of snout 2·80 diameter of eye 3·15, width of interorbit 4·20, length of maxillary 2·66, of mandible 2·10, height of spinous dorsal 1·80, length of ventral 2·00 in length of head.

Body elongate-elliptical, somewhat compressed, its width 1·50 in its depth, the dorsal and ventral profiles about equally convex. Depth of head 1·50 in its length; snout pointed, longer than the eye-diameter, which considerably exceeds the feebly convex interorbital width; adipose lid greatly developed, extending well over the preorbital and opercular regions, and leaving uncovered only a narrow vertical slit, of which the pupil is the centre; cranio-nuchal ridge moderate, extending forward on the snout; lower jaw the longer; maxillary scarcely extending to the level of the eye, the width of its emarginate distal extremity 2·50 in the eye-diameter. A narrow band of fine teeth in the jaws; vomer, palate, ptergyoids, and tongue smooth.

Scales smooth, in regular series; throat and breast scaly; occiput, posterior half of interorbit, inner half of opercle and subopercle, interopercle, and cheeks scaly; head elsewhere naked; soft dorsal and anal fins with a low basal scaly sheath. Lateral line straight to above the middle of the appressed pectoral, thence gently curved to below the anterior third of the soft dorsal, beyond which it is again straight; posterior portion 1·40 in the anterior, bearing 31 plates, which are well developed posteriorly, where each is armed with a strong sharp spine; anteriorly the line is continued in a wide loop over the nape, meeting its fellow immediately behind the nuchal ridge, and forming a definite boundary between the minute occipital and the larger body scales; the loop itself is bisected by a short supplementary line, which passes forward along the interorbit and backward over about 7 scales. Caudal peduncle without subsidiary keels.

Spinous dorsal originating behind the base of the pectoral, the 3rd spine longest, two fifths longer than the 2nd ray, which reaches, when depressed, to the base of the 9th ray; origin of soft dorsal above the vent. Detached anal spines strong and subequal, 2·25 in the eye-diameter, united basally by membrane to one another and to 3rd spine, which is inserted below the 6th dorsal ray; anal

fin one third longer than the abdomen, its anterior lobe about as high as the soft dorsal. Caudal fin forked, the middle rays shorter than the eye; caudal peduncle wider than deep. Pectoral fin slightly curved, extending to below the origin of the soft dorsal. Ventral small, reaching midway to the base of the 2nd anal spine.

Gill-rakers long and slender, 13+35, the longest 1·80 in the eye-diameter, but not quite so long as the middle fringes.

Above olive green, lightest on the head, below pearly white; a blackish opercular spot; base of pectoral dark; fins colorless.

Described from a Moreton Bay specimen, 230 millim. long, in the A.F.A.Q. Museum; Cat. No. 1134.

AMBASSIDÆ.

Priopis olivaceus sp. nov.

D. viii,* i 7; A. iii 8; P. 12: Sc. 23-15; L.l. 0 to 4. Depth of body 2·55, of caudal peduncle 6·6, length of head 2·85, of caudal fin 2·85 in length of body. Length of snout 4·1, diameter of eye 3, width of interorbit 4·35, longest dorsal spine 1·65, longest anal 2·15, length of pectoral 1·25, of ventral 1·4 in length of head.

Upper profile of head linear, the nape convex with an appreciable median ridge; interorbital region convex; maxillary scarcely extending to below the anterior border of the eye. Preopercle with 5 or 6 strong spines at and below the angle. Head scales as large as those of the body.

Procumbent dorsal spine well developed; spinous dorsal originating above the 4th body-scale, the 3rd spine longest and strongest, a little higher than the rayed dorsal; spine of soft dorsal 1·35 in the height of the spinous dorsal. Anal fin originating below the 12th body-scale; 3rd spine longest, as long as that of the soft dorsal, a little longer than the base of the fin, and 1·35 in the 1st ray, which is as high as that of the dorsal. Caudal fin deeply forked, the middle rays about half as long as the lobes. Third and 4th pectoral rays longest, extending to the 10th body-scale. Ventral shorter than the pectoral, the two outer rays longest, reaching to the vent, the spine as long as the 3rd anal spine.

Green above, yellowish white below; a black line,

* The procumbent spine included.

which is feebly curved anteriorly, from the upper angle of the opercle to the root of the caudal; the scales forming the series through which this line runs are profusely dotted with black, as also are the edges of all the scales above the line, and anteriorly the surface of the scales is similarly but more sparsely dotted; two or three series of body-scales below the line and the scales of the tail with a single marginal series of black dots. Upper surface of head and nape and the opercles so profusely dotted as almost to obscure the ground color; cheeks and lower surface of head less closely dotted. All the fins similarly marked, the dots being most crowded on the membrane of the second dorsal spine, the tips of the anterior anal rays, and the middle ventral rays.

Abundant in all creeks and waterholes in the Brisbane district. Description taken from a 50 millim. example in the A.F.A.Q. Museum, to which it was presented by Mr. W. E. Weatherill; Cat. No. 463.

PRIOPIS NIGRIPINNIS sp. nov.

D. vi, i 8; A. iii 8; P. 10; Sc. 25-12; L. 0 to 6. Depth of body 2·85, of caudal peduncle 7·9, length of head 2·9, of caudal fin 2·8 in length of body. Length of snout 3·8, diameter of eye 2·8, width of interorbit 4·05, longest dorsal spine 1·5, longest anal 1·95, length of pectoral 1·3, of ventral 1·45 in length of head.

Upper profile of head linear, the nape feebly convex and with a well defined median ridge; interorbital region convex; maxillary extending to below the anterior border of the eye. Preopercle with a few strong spines at the angle. Head scales as large as those of the body.

No procumbent dorsal spine; spinous dorsal fin originating above the 7th body scale, the 1st spine longest and strongest, somewhat higher than the rayed dorsal; spine of soft dorsal 1·3 in the height of the spinous dorsal. Anal fin originating below the 14th body-scale, the 3rd spine longest, as long as that of the soft dorsal, a trifle longer than the base of the fin, and equal to the 1st ray, which is higher than that of the dorsal. Caudal fin deeply forked, the middle rays about two fifths of the length of the lobes. Fourth pectoral ray longest, extending to the 11th body scale. Ventral a little shorter than the pectoral, the two

outer rays longest, reaching slightly beyond the vent, the spine as long as the 3rd anal spine.

Uniform violaceous brown, somewhat lighter below; edges of all the upper scales clouded with numerous black dots; lower scales and those of the head with scattered dots; a narrow black line from the tip of the appressed pectoral to the root of the caudal. Fins dusky; membrane of first dorsal spine densely powdered with blackish spots; tips of the anterior soft dorsal and anal rays black.

Inland creeks in the Moreton District. Description taken from a 45 millim. example in the A.F.A.Q. Museum, obtained in Kilcoy Creek by Dr. T. Bancroft, and presented by him to the Association. Cat. No. 1342.

LABRIDÆ.

CHŒRODON VITTA sp. nov.

D. xiii 7; A. iii 10; P. 16: Sc. 3-27+2-10. Depth of body 2·9, of caudal peduncle 7·7, length of head 3·15, of middle caudal rays 5·9, of pectoral and ventral fins 4·5 in length of body. Length of snout 2·45, diameter of eye 4·1, width of interorbit 3·5, last dorsal spine 3·05, last anal spine 2·9 in length of head.

Dorsal profile of body evenly and gently rounded, not appreciably higher than the ventral profile, its highest point above the middle of the appressed pectoral. Head about one sixth longer than deep; upper profile of snout gently rounded and moderately declivous; eye moderate, its diameter rather less than the depth of the preorbital. Cleft of mouth extending to below the anterior nostril. Anterior canines large; lateral mandibular teeth without prominent tips; no posterior canine. Preopercle finely serrated. Cheeks with eight series of small subimbricate scales; some of the opercular scales larger than the breast-scales; scales at the base of the caudal angulated and but little enlarged.

Soft dorsal and anal fins low, rounded and subequal in height posteriorly, scarcely extending to the caudal fin, and with a low scaly sheath. Caudal fin emarginate. Fourth pectoral ray slightly longer than the third, reaching to below the tenth scale of the lateral line. Outer ventral ray the longest, extending to the vent.

Reddish brown, darkest above; two to four narrow, sometimes anastomosing, silvery lines on the cheeks and

preorbitals; a broad blackish band along the middle of the body from behind the eye to the caudal peduncle, separated by a short interspace from a large oval black spot in front of the root of the caudal; fins uniform pale rufous.

Total length (of type) 190 millim.

Aru Islands.

Type in the A.F.A.Q. Museum; Cat. No. 1394.

In company with the West Australian *C. rubescens* and the East Australian *C. macleayi* this Tuskfish forms a well-marked group, characterized by the smaller size, more slender habit, and uniform or nearly uniform coloration, which in the species mentioned is rufous brown in marked contrast to the more brilliant livery of the larger species. With these three should also be associated De Vis' *C. olivaceus.*

CHÆTODIDÆ.

MEGAPROTODON MACULICEPS sp. nov.

D. xiv 18; A. iv. 15: Sc. 6-46-15; L.l. 36. Depth of body 1·75, length of head 3·15, of pectoral fin 3·4, of ventral 3·4 in length of body. Diameter of eye 2·4, width of interorbit 2.75, longest dorsal spine 1.35, longest anal 1·25, length of caudal 1·5, depth of peduncle 2·75 in length of head.

Upper profile of head moderately steep and undulous owing to a slight protuberance above the posterior half of the eye. Snout slightly produced and obtusely pointed, 1·25 in the eye-diameter; interorbital region convex; jaws equal; maxillary extending to below the anterior nostril. Preopercle serrated. Scales moderate, those on the middle of the trunk somewhat larger than the anterior scales and much larger than those on the tail, which rapidly decrease in size posteriorly: lateral line but little arched in front, not extending to the caudal peduncle.

Dorsal fin broadly anal narrowly rounded behind, the spinous portion of the former twice as long as the soft portion; 4th and 5th dorsal spines equal and longest, a little longer than the soft rays. Second anal spine longest and strongest, somewhat longer than the dorsal spines and one fourth longer than the rays, which are slightly shorter than those of the dorsal. Caudal fin feebly rounded. Pectoral pointed, the 4th ray longest, reaching

to the 12th body-scale. Ventral as long as the pectoral, extending to the vent.

Colors (after long immersion in alcohol). Pale rufous, with five rather wide dark longitudinal bands following the curvature of the back above the lateral line and twelve much narrower linear bars below; a large black elliptical spot covers the upper middle portion of the side from above the middle of the pectoral fin to below the anterior third of the soft dorsal; about two thirds of it are below the rest above the lateral line, and the two lower longitudinal bands and three upper bars are lost in it; a large oval black spot on the side of the tail, partly below the end of the soft dorsal and partly on the peduncle, across the upper edge of which it extends but does not reach the lower border. Ocular band running from a short distance in front of the dorsal through the eye to the interopercle, darkest superiorly, and somewhat interrupted by a lighter spot where it leaves the nape; opercle with several large dark brown spots. Soft dorsal and anal fins each with a narrow dark inframarginal band, which extends forward on the former to the posterior rays; caudal fin with a wide pale brown basal and a dark brown subarcuate median band.

Described from a Moreton Bay specimen, measuring 75 millimeters, in the collection of the Queensland Museum.

Closely allied to *Megaprotodon plebius**, from which it differs chiefly in the color markings. The lateral blotch bears a close resemblance to that of *Chætodon speculum*† as figured by Bleeker‡, but is more pointed at either end.

TRIACANTHIDÆ.

TRIACANTHUS FALCANALIS sp. nov.

D. v or vi—22 or 23; A. 18; P. 16. Depth of body 2·75, length of head 3·35, of snout 4.85, of first dorsal spine 3·55, of ventral spine 4·3, of pelvic bone 5·, of soft dorsal 3·55, of anal 5·5, of caudal 3·85, of caudal peduncle 5·1 in length of body. Diameter of eye 3·85, width of inter-

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**Chætodon plebeius* Gmelin, Syst. Nat., 1789, i, p. 1269. In Turton's translation, 1806, no mention is made of this species.

† *Chætodon speculum* (Kuhl & v. Hasselt) Cuvier & Valenciennes, Hist. Nat. Poiss, vii, 1831, p. 73.

‡ Atlas Ichth, pl. CCCLXXV, fig. 3.

orbit 3·65, of gill-opening 4·6, height of soft dorsal 3·55, of anal 2·5 length of pectoral 2·3 in length of head.

Upper profile of snout linear, its length 1·45 in that of the head and 1·35 in the space between the eye and the soft dorsal. Distance of eye from gill-opening 1·15 in the diameter of the eye, which is 1·5 in its distance from the dorsal spine; interorbital region concave (nearly flat in large examples), without indication of a median ridge. Gill-opening entirely behind the eye, commencing in front of the lower third of the pectoral.

Dorsal spine feebly curved or straight, tapering to an acute point, inserted above the base of the pectoral, and entirely covered with coarse granules, which are somewhat more enlarged and pointed in front and behind, its distance from the soft dorsal 2·3 in that from the tip of the snout; soft dorsal with rounded outline, the highest part about the end of its first third, where it is 3·4 in its length. Anal fin much higher than the soft dorsal, below the eleventh or twelfth ray of which it originates and with which it is conterminous; its outline is deeply emarginate, the anterior rays being produced and falciform, 1·5 in the base of the fin, which is 1·55 in that of the soft dorsal. Caudal fin deeply forked, the middle rays 3·25 in that of the outer; caudal peduncle distally cylindrical. Base of pectoral fin 1·5 in the width of the gill-opening. Ventral spines reaching to or not quite to the vent. Pelvic bone tapering to a point behind.

Silvery, washed with bronze above; two large oval dark blotches on the back, one below each dorsal fin anteriorly; two similar blotches on the side, the one above the other behind the pectoral; base, lower half of membrane, and outer half of dorsal spine except the extreme tip blackish.

Total length 260 millim.

Coast of Southern Queensland. Brisbane River and Moreton Bay, common.

Described from six examples, measuring from 150 to 256 milimeters.

TETRAODIDÆ.

SPHEROIDES SQUAMICAUDA sp. nov.

SCALY-TAILED TOAD-FISH.

D. 9; A. 7; P. 15. Depth of body (at the vent) 4·2, length of head 3 in length of body. Diameter of eye 2·6, width of interocular region 6·25, height of dorsal 1·45, length of caudal 1·15, of pectoral 1·5 in length of head.

Body robust, evenly and gently rounded to above the middle of the pectoral fins, beyond which it slopes downward to the caudal. Anterior profile of head linear and slightly oblique, the mouth below the level of the eye; length of head a little less than that of the trunk. Eye large, narrowly free below, its diameter about equal to the length of the snout; interocular region narrow and concave, its width 2·4 in the eye. Nostrils pierced in a conspicuous rounded tentacle. A narrow band round the lips and an ovate gular patch naked; rest of head and trunk closely studded with flexible spinules, which do not quite extend to the dorsal fin above nor to the vent below, but are continued backward on the upper side to below the origin of the dorsal where it meets the lateral line, the intervening border concave; between the lateral line and the vent there is also a naked embayment stretching forward to the tips of the appressed pectoral rays; tail spineless, with a low ridge on either side of the lateral line, each of which bears a series of unarmed squamiform processes. Lateral line forming a gentle curve to below the orgin of the dorsal, thence straight to the caudal fin; a linear connecting line across the nape, beyond which the main line curves gradually downward to behind the lower third of the eye where it trifurcates, the middle branch passing directly forward to the angle of the mouth, the others branching off at right angles, the upper eventually curving forward above the eye to between the nostrils, the lower ceasing in front of the inferior angle of the gill-opening. Sides of tail with a well-developed ridge. Width of gill-opening rather more than the base of the pectoral, and extending well above it, the inner flap not protruding, the outer with a flat tentacular process on its lower half.

Dorsal fin falcate, with the extreme tip rounded, its length 2·85 in its height. Anal rounded, originating

below the middle of the dorsal, than which it is much shorter and lower. Caudal fin elongate and rounded, as long as the peduncle. Outer edge of pectoral linear above rounded below.

Upper surface lilaceous with numerous small blackish spots; sides gray, profusely dotted with darker; a moderately wide dusky band separates the two colors on the tail running just below the lateral line; under surface immaculate white: fins colorless.

Total length 80 millim.

Coast of Southern Queensland.

Described from the single example known.

DIODONTIDÆ.

DICOTYLICHTHYS MYERSI sp. nov.

D. 12; A. 11; P. 20. Width of body 2·85, depth of body 2·85, length of head 2·70 in the length of the body. Length of snout 3·50, diameter of eye 3·05, width of interorbit 2·00, height of dorsal and anal fins 2·00, length of caudal 1·50, of pectoral 2·00 in the length of the head.

Snout linear, rest of head convex above; mouth below the level of the eye. Head much longer and a little deeper than wide, its length 1·30 in the trunk. Eye moderate, without free lid; interorbital region concave. Nasal tentacle bifurcate. Spines of head and lower surface erectile, of back and sides fixed, the abdominal and subcaudal spines much smaller than the others, which are of about equal size throughout, the longest pair being on each side of the caudal peduncle and not so long as the diameter of the eye; no turbinal nor preorbital spines; frontal region with a conspicuous median spine, outside and behind which is a pair of rather smaller lateral spines; inside and behind these are yet another pair, the inner roots of which overlap one another; beyond these again are three other pairs similarly arranged, while the hinder border of the occiput is armed with a single spine corresponding to the frontal spine; two short, widely separated supraorbital spines, followed by a series of eight spines, the first three belonging to the temporal region, the last below the dorsal; cheeks and opercles with short sharp spines; caudal peduncle with two pairs, the bases of the upper far overlapping above. Gill-opening narrower than the base of the pectoral.

Vertical fins rounded, the length of the dorsal somewhat more than that of the anal, which is inserted almost wholly behind the dorsal, and about 2·50 in their respective heights; caudal fin rounded, the peduncle deeper than wide: pectoral undulous, the upper angle slightly produced, the lower broadly rounded, the width of its base more than the eye-diameter.

Uniform olive-brown, shading into lavender or dull white below; lower part of the sides and entire under surface of the body, with small black spots; a black vertical band below the eye, a second in front of the gill-opening, and a third below the tip of the appressed pectoral. Fins uniform gray.

Total length 290 millim.

Coast of South-Eastern Queensland.

Described from three Moreton Bay specimens, measuring from 200 to 290 millimeters.

Type in the A.F.A.Q. Museum, to which it was presented by Mr. Harry Myers, of Brisbane, after whom I have great pleasure in naming it.

This species is easily distinguishable from *D. punctulatus** by the small size of the abdominal spines, which are much shorter than those of the back and sides, and from *D. jaculiferus*† by the conspicuous mid-frontal spines, the absence of the elongate pectoral spines, and the formula of the vertical fins.

CHILOMYCTERUS GRANDOCULIS sp. nov.

D. 12; A. 11; P. 21. Width of body 2·25, depth of body, 2·50, length of head 2·60 in the length of the body. Length of snout 2·85, diameter of eye 2·20, width of interorbit 1·85, height of dorsal fin 1·80, of anal 1·95, length of caudal 1·35, of pectoral 1·80 in the length of the head.

Snout linear, rest of head convex; mouth below the level of the eye; head as wide as long and two fifths wider than deep, its length 1·30 in the trunk. Eye large, without free lid; interorbital region flat, the supraciliary edges slightly raised. Nasal tentacle compressed and simple. A short strong turbinal spine; a much smaller preorbital spine; frontal region with a single median spine, its point reduced to a blunt tubercle, or more rarely a pair

* Kaup, Arch. f. Nat., 1885, p. 230: Cape Seas and Mauritius.

† *Diodon jaculiferus* Cuvier, Mém. Mus., 1818, p. 130.

of similar spines arranged transversely; three supraorbital spines, the last pair close together and well separated from the first, followed by a similarly arranged temporal series of three, the last above the base of the pectoral; cheek-spines not piercing the skin; a few small opercular spines: spines of body strong and fixed, those in front short, quickly increasing in length backward the tip of the appressed pectoral: four spines in an irregular row behind the temporal series; a single greatly produced movable spine behind the middle of the base of the pectoral, its length equaling the interorbital width: a similar but somewhat shorter spine behind the lower angle of the pectoral; middle series of abdominal spines short and blunt; peduncle naked. Gill-opening much narrower than the base of the pectoral.

Vertical fins rounded, the length of the dorsal 2·20, that of the anal, which is inserted behind the dorsal, 2·85 in their respective heights: caudal fin rounded, the peduncle deeper than wide; pectoral emarginate, the width of its base equal to the eye-diameter.

Dull violet or olive-green above, the tips of some of the spines darker, below white; sides with three usually circular black spots, the first in front of the lower angle of the gill-opening, with often a smaller spot above it; the second below or just behind the middle of the border of the appressed pectoral, sometimes with a smaller spot below and behind it; the third midway between the origins of the vertical fins; all these spots surround the base of a spine, and occasionally the third temporal spine is similarly favored. Fins pale brown, the caudal with a darker tip.

Total length 250 millim.

Coast of Southern Queensland (Brisbane River and Moreton Bay).

Four examples, measuring from 130 to 250 millimeters have been examined in the preparation of this article.

This species, the common "Porcupine-Fish" of the Moreton Bay Fishermen is easily distinguishable from all the other *Chilomycteri* not only by the size of the eyes, but especially by the two erectile dagger-like spines, which protect the pectoral region on each side.

Type in the collection of the A.F.A.Q., to which it was presented by Mr. Charles Sigley; Cat. No. 41.

GOBIIDÆ.

VALENCIENNEA ARUENSIS sp. nov.

D. vi, i 12 ; A. i 12 ; P. 19 : Sc. 92-42. Depth of body 5·1, of caudal peduncle 9·1, length of head 3·5, of soft dorsal, 3·35, of caudal fin 3·5 in length of body. Length of snout 2·7, diameter of eye 5·1, width of interorbit 5·5, length of maxillary 2·6, longest dorsal spine 1·25, last dorsal ray 1·55 (♂) 1·9 (♀), length of pectoral 1·25, of ventral 1·8 in length of head.

Depth of head 1·65, width of head 1·4 in its length. Snout evenly rounded above, nearly twice as long as the diameter of the eye ; interorbital region flat ; maxillary extending to below the anterior border of the eye.

Spinous dorsal originating above the base of the pectoral, the 3rd spine produced ; last dorsal ray longest, extending well on the rudimentary caudal rays, 1·2 (♂) 1·6 (♀) in the 3rd spine. Anal fin originating midway between the root of the caudal and the vertical limb of the preopercle and below the 2nd ray of the soft dorsal, with which it is conterminous, the last ray much shorter than (♂) or as long as (♀) that of the dorsal. Caudal fin cuneate : caudal peduncle short and stout, as deep as long. Pectoral reaching to below the origin of the soft dorsal. Ventral extending more than half way to the vent, the 3rd or 4th ray longest.

Width of gill-opening twice the diameter of the eye ; 7 gill-rakers on the lower branch of the anterior arch, the longest 2·5 in the eye.

Pale olive-green, the back with ten broad darker cross-bands, of which two are on the nape, two below the spinous dorsal, four below the soft dorsal, and two on the peduncle ; these bands are much darker, sometimes almost black, marginally than mesially, the middle portion being but little darker than the ground color ; sides of head and body with two chestnut stripes, the upper from the tip of the snout to the below middle of the soft dorsal, the lower from behind the eye to the upper third of the caudal, the former bisecting, the latter forming the lower border of the cross-bands ; below these again is a series of six dark spots, which are connected with one another inferiorly, so as to form a third rather obscure stripe between the base of the

pectoral and the lower third of the caudal, and transversely with the median stripe by narrow cross-bars, which may be interrupted or even absent. Head without spots; snout and opercles dull violaceous brown; two narrow silvery undulous bands from and above the corner of the mouth to the opercle, upon which the lower curves upward and forms a junction with the upper; they are also united by a narrow bar along the edge of the preopercle, and the upper bar is occasionally produced forward across the lip; there are sometimes two similar short bars in front of the eye. Spinous dorsal with a black terminal spot on the membrane of the third spine and with six narrow undulous bars running obliquely upward and backward from its base; anal with an indistinct infrabasal band; caudal colorless, or with several obscure cross-bands, or with small but distinct purple spots on its basal half inferiorly, and always with a wide terminal silver-edged violet band.

Described from 4 Aru Island specimens in the A.F.A.Q. Museum, the largest and type 120 millim.; Cat. No. 986.

BUTIS LONGICAUDA (De Vis).

D. vi, 9; A. 9; P. 18 or 19: Sc 29 or 30-10 or 11. Depth of body 4·7, of caudal peduncle 8·4, length of head 2·9, of caudal fin 4 in length of body. Depth of head 2·5, width of head 1·66, length of snout 2·66, diameter of eye 5·75, width of interorbit 4·25, length of maxillary 2·66, longest dorsal ray 2·2, longest anal 2, length of pectoral 1·45 in length of head.

Snout greatly depressed, more than twice the diameter of the eye; interorbital region flat, broader in the male than in the female or young*; supraciliary ridge crenulate; maxillary varying much with age and sex, extending nearly to or slightly beyond the anterior border of the eye.

Head almost wholly scaly, the scales on the upper surface small; lower surface of head, extremity of snout, nasal region, maxillaries, and a pair of narrow channels extending from the snout along the frontal region, inside the supraciliary ridges, to and beyond the postero-superior border of the eye, and thence to the upper angle of the

* In a fine male measuring 140 millim. the width of the interorbital region is 3·75 in the length of the head, in a female of 135 millim. the same measurement is 4·35.

opercle naked. Most of the scales of the body and opercles with from 1 to 4 subsidiary squamulæ.

Third dorsal spine longest a little shorter than the snout and 1·35 in the longest ray.* Anal fin originating below the 2nd dorsal ray and conterminous with the soft dorsal, its last ray in both sexes longest but not reaching to the caudal. Caudal fin rounded, the peduncle long, 2·2 times as long as deep.† Pectoral fin reaching to the origin of the 2nd dorsal. Ventral rather more than midway to the anal.

Dark chestnut brown or purple, uniform or with the scales of the lower sides and tail narrowly edged with yellow. Dorsal, anal, caudal, and ventral fins purple, the anterior borders and the tips of the dorsals, the upper border and tips of the upper rays of the caudal, and the tips of the anal and ventral rays crimson, fading into saffron or white after brief immersion in a preservative; occasionally the whole 2nd dorsal is crimson with the exception of a basal purple band ornamented with a few clear spots; caudal and sometimes the last anal rays also with clear spots, which may be large and few in number, but are more commonly small and crowded; pectorals uniform yellow, with a large black white-edged basal ocellus.

The "Crimson-tip Gudgeon" attains a length of 200 millim. and is one of the most common estuary fishes of our southern Queensland Rivers, and its presence may always be anticipated in any collection from the streams running into Moreton Bay. Personally I have examined specimens from the Tweed River,‡ Nerang Creek, the Logan, Brisbane, and Pine Rivers, Nocsa Creek, and the Mary River, and its range probably extends well beyond these limits. It may always be recognised by the crimson (white) tips to the fins and by the squamulæ which cover the anterior portion of the scales, and which are absent in all our other eleotrins. The only substance found in the stomach of the specimen dissected was the head of a small

* In the male fish the last dorsal ray is the longest and is considerably produced beyond the others, in the female the 2nd or 3rd ray is the longest, 1·5 time the length of the last ray.

† The peduncle is more slender in the immature than in the adult.

‡ Thus adding another genus and species of eleotrin to the fauna of New South Wales.

fish, apparently some species of goby. These little fishes are said to be excellent eating.

Described from 5 recent examples from the Brisbane River, and 1 each from the Tweed and Mary Rivers and Noosa Creek, the measurements of the 8 specimens being from 75 to 140 millim. I have also examined De Vis' types from the Brisbane River, as also a specimen from the same source, to which is attached the Museum label "*Eleotris papa* De Vis"; and yet another, without locality, labeled "*Eleotris aporos*." From this species, which belongs to the allied genus *Ophiocara*, it may easily be distinguished by the small size of the occipital scales, which in *O. aporos* are as large as those of the body.

RHINOGOBIUS LEFTWICHI sp. nov.

D. vi, 10; A. 10; P. 16: Sc. 30 to 32-10. Depth of body 4·6, of caudal peduncle 8·85, length of head 3·5, of caudal fin 3·6 in length of body. Length of snout 2·95, diameter of eye 3·85, longest dorsal spine 1·5, length of anal 1·25, of pectoral 1·15, of ventral 1·2 in length of head.

Depth of head 1·5, width of head 1·45 in its length. Diameter of eye 1·3 in the length of the snout; width of concave interorbital region less than one third of the diameter of the eye; cleft of mouth reaching to below the posterior nostril.

Third dorsal spine longest, rather less than the space between its base and the preopercle; soft dorsal and anal fins but little lower than the spinous dorsal. Anal originating below the 3rd dorsal ray and conterminous with the soft dorsal. Base of pectoral 2·6 in its length. Ventral not reaching to the vent.

Pale yellowish brown, all the scales, except those along the ventral profile, edged with dark brown; in half grown examples there is a row of darker blotches along the middle of the sides, with sometimes a second row near the dorsal profile, the anterior spots often meeting across the nape. Upper surface of head and nape spotted and vermiculated with brown; an indistinct violaceous band curves downward from the eye to the angle of the mouth, behind which are two parrallel bands, which extend upon the base of the pectoral; opercles dull purplish. Fins hyaline, closely powdered with dusky dots; dorsals with a basal row of dark spots; last two dorsal and anal rays

with alternate darker and lighter bars, sometimes absent in the anal ; caudal with a dark basal band. (Named for Mr. R. W. Leftwich, Junr., of Maryborough, to whom I am indebted for many kindnesses).

Described from 6 specimens in the A.F.A.Q. Museum, collected in Great Sandy Strait, and measuring from 58 to 75 millimeters ; Cat. No. 1132.

This pretty little goby abounds in the pools left by the receding tide on the oyster banks in the Great Sandy Strait, and I have also seen specimens obtained in the vicinity of Woody Point, Moreton Bay. Along the edges of these pools when undisturbed they lie motionless, basking in the shallow water, but if alarmed by the approach of an enemy they dart away with great rapidity, and seek refuge in the deeper water below or within the bunches of oysters, adjusting their bodies with great nicety to the inequalities of the surface on which they have found a haven. Here their colors assimilate so closely with their surroundings that it requires a keen eye to locate their position even though one may have been but a few feet from them when they sought concealment ; they are very quick in their movements, and even with a hand net it is most difficult to catch them. I have never observed one of these fishes to take refuge in a hole as is the usual habit of *Amblygobius gobioides,* which is equally common on the oyster beds. The stomach of the example dissected was packed with green weed regularly cut into lengths of about an inch, with which also was a shrimp-like crustacean of about the same size.

AMBLYGOBIUS GOBIOIDES (Ogilby).

D. vi 13 ; A. 12 ; P. 16. Depth of body 6·25, of caudal peduncle 9, length of head 4, of caudal fin 3·8 in length of body. Diameter of eye 5·5, length of pectoral 1·3 in length of head.

Depth of head 1·65, width of head 1·35 in its length. Diameter of eye 1·4 in the length of the snout ; width of interorbital region less than half the eye-diameter ; cleft of mouth reaching to below the anterior border of the eye.

Third dorsal spine longest about one fourth longer than the head, and as long as the distance between its base and the anterior border of the eye ; second dorsal and anal fins low, their longest rays 2 in the 3rd spine.

Anal originating below the 2nd dorsal ray and conterminous with the soft dorsal, its base one fifth more than the head. Base of pectoral 2·6 in its length. Ventral fin 1·25 in the pectoral, reaching midway to the anal.

Purplish or reddish brown above, gradually fading into lilac below, the sides with from 40 to 50 alternate darker and lighter transverse bands, which in large examples are usually broken up into vertical bars. Upper surface and sides of head and nape with numerous round blackish spots. Fins vinous: anterior border of first dorsal white; sometimes a dark marginal spot between the fourth and fifth spines and some oblique dusky streaks basally; second dorsal with three series of dark spots: caudal sometimes with a few scattered spots. When newly caught, the lateral transverse bars are brilliant blue and gold. (*Gobioides*: a genus of Gobies to which this species bears some resemblance in its strengthened dentition and the obliquity of its mouth.)

Total length 120 millim.

Type in the Macleay Museum, Sydney University.

East Coast of Australia. I have seen and examined numerous specimens from Port Jackson, the Richmond River, various parts of Moreton Bay, and Great Sandy Strait, in all of which places it is abundant wherever suitable ground exists. It may therefore be safely predicted that its range, both southward and northward, extends well beyond the limits here given.

This species is essentially a "mud goby." In the Wide Bay District I had many admirable opportunities of observing its habits on the vast flats left bare by each recurring tide The fish either excavates for itself a burrow in the mud or takes possession of the deserted burrow of a worm or crab, and enlarges it to suit its own convenience.* The burrow is invariably provided with two openings, which may be at the bottom of a small pool, but as often as not open upon the bare mud. Here, if one approaches cautiously, the little creature may be seen lying—regardless of or perhaps enjoying the fierce rays of a semi-tropical summer sun—close to the burrow, bent into the shape of a U with one of the sides shortened, its head turned to-

* When digging these fishes out I have never found any other animal occupying the burrow along with them.

wards the entrance, through which it disappears like a flash on any incautious movement of the spectator. If, however, perfect quiet be maintained the head will shortly be seen to emerge from the other entrance, intently scrutinizing its surroundings to ascertain whether the danger be past. When they take refuge at the bottom of their retreat it is not an easy matter to dig them out.

Described from five specimens collected in Great Sandy Strait by myself and a much larger example obtained at Woody Point by Mr. J. T. Jamison.

Gobius cristatus Macleay, Proc. Linn. Soc. N.S. Wales, v, 1880, p. 610 (20 May, 1881): Port Jackson.

Gobius gobioides Ogilby, Catal. Fish. N. S. Wales, 1886, p. 35. Substitute for *G. cristatus* Macleay, preoccupied—Stead, Eggs and Breed. Hab. Fish, 1907, p. 60.

SCORPÆNIDÆ.

Scorpænopsis palmeri sp. nov.

D. xii 10; A. iii 5; P. 17 (1 + 5 + 11): Sc. 8-45 to 47-13*; L. lat. 22 or 23. Depth of body 3, of caudal peduncle 8·75, length of head 2·6, of caudal fin 4, of pectoral 3·55, of ventral 4 in length of body. Length of snout 2·85, diameter of eye 4·5, width of interorbit 6·55, length of maxillary 1·9, of longest dorsal spine 2·1, of longest anal 1·8 in length of head.

Snout long, its upper profile strongly convex, the preocular groove deep; lateral interorbital ridge low, not ending in a spine; an anterior median ridge, bisecting the preocular groove; lower jaw the longer, without symphysial protuberance; maxillary extending to below the middle of the eye, the width of its distal extremity equal to or a trifle more than that of the interorbit. Nasal, preocular, postocular (2), exoccipital, nuchal (2), tympanic, and parietal (3) spines present. Preorbital with a strong median hooked spine, from which radiate four smooth ridges, only the lower anterior of which terminates in a spine; the posterior ridge is continuous with that of the suborbital, which is armed with three strong spines; behind these, but separated from them by a groove, is a stout double preopercular spine, below which are four graduated ridges,

* Above first anal spine.

the two upper ending in more or less conspicuous spinous points: opercle with two strong spines at the end of divergent ridges, the upper spine the longer. Occipital groove deep and transversely oblong, bordered anteriorly by a sharp ridge, which is highest externally. Two or three small cirri on the head of the maxillary and a much larger fringed one behind the anterior nostril; supraorbital ridge sometimes with a small cirrus; a large fringed cirrus near the distal end of the preorbital and a series of six smaller ones round the chin, behind which are a still smaller pair on the median line; some well developed fringed cirri on the body, principally along the lateral line, which is without spinous plates anteriorly. Scales in fairly regular series; fins naked.

Length of soft portion of dorsal fin 1·9 in that of the spinous portion; first dorsal spine a trifle longer than the eleventh and 2·5 in the fourth, which is a little longer than the third or fifth; last spine 1·4 in the height of the soft dorsal, which is equal to that of the spinous. Second anal spine much stronger and longer than the third, as long as the anterior rays, and higher than the spinous dorsal. Caudal fin rounded. Pectoral extending to a little beyond the vertical from the vent, the width of its base 1·85 in the fifth and longest ray. Ventral reaching to the vent, which is an eye-diameter in front of the anal fin.

Gill-rakers 5 + 11, all but the pair at the angle tubercular.

Pale brown blotched with blackish brown, the most pronounced markings being across the nape, between the middle of the spinous dorsal and the lateral line, and between the soft dorsal and the anal; in addition to these the ground color is profusely freckled with darker; a small whitish spot at the base of the last dorsal ray and a second sometimes at the root of the caudal; throat and abdomen pearly white: head somewhat darker than the back and sides, the blotches, however, being replaced by dark brown spots, the lower surface dirty white, anteriorly freckled or stained with yellowish brown, the mental cirri and a few scattered spots darker brown; a vertical black bar between the eye and the suborbital ridge; a silvery spot on and behind the interorbital region present or absent. Spinous dorsal blackish, with an irregular suprabasal and infra-

marginal silvery or lilac band, the spines with alternating bars of dark brown and pearly white; soft dorsal lilac, profusely freckled with rufous, the base, an obliquely oval anterior spot, and the last rays blackish: anal fin gray, spotted and freckled with dark brown; anteriorly with two pairs of broad alternate white and brown bands: caudal lilac, with a dusky base and a broad submarginal black band, the marginal band also freckled with black: pectoral gray, with two broad dark cross bands on the upper half, the lower half with ocellated violet dark-edged spots, the base fuscous spotted with lilac: outer half of ventrals with two black cross-bands or irregularly spotted and lined with black; an oval blackish spot on the base anteriorly.

Total length 200 millim.

Coast of Southern Queensland (Moreton Bay).

Described from two examples measuring respectively 165 (type) and 202 millimeters.

SCORPÆNOPSIS MACROCHIR sp. nov.

D. xii 10; A. iii 5; P. 16 (1 + 4 + 11): Sc. 6-41-14; L.l. 22. Depth of body 2·35, length of head 2·35, of caudal fin 4·15, of pectoral 2·7, of ventral 3·85 in length of body. Length of snout 3, diameter of eye 4·75, width of interorbit 3·9, length of maxillary 1·9, longest dorsal spine 2·85, longest anal 2 in length of head.

A deep naked pit below the anterior border of the eye; lateral interorbital ridge inconspicuous; no median ridge; lower jaw the longer, without symphysial protuberance; maxillary extending to below the hinder border of the eye, the width of its distal extremity 1·5 in that of the interorbit. Nasal, preocular, supraocular (2, the posterior large with a serrated upper edge), postocular (2 small and erect), exoccipital, nuchal (2), tympanic, and parietal (4, the last 3 united by a sharp continuous ridge) spines present. Preorbital with a small median spinous point, from which radiate three low ridges, one directed downward, one forward, and one backward, each terminating in a short stout spine; suborbital ridge with 3 strong spines; preopercle with 4 spines, the upper strongest and double; opercle with 2 widely divergent ridges, each terminating in a small spine. Occipital groove deep and transversely oblong, bordered anteriorly by a low arcuate ridge. Head and body without cirri, except a pair of small ones anteriorly on the

preopercle. Postocular region and upper half of opercle scaly; body scales rather irregularly arranged; fins naked, except the upper half of the base of the pectoral; lateral line without spinous plates anteriorly.

Length of soft dorsal fin 2·6 in that of the spinous; 1st dorsal spine 1·3 in the 11th, and 1·75 in the 4th, which scarcely exceeds the 3rd and 5th: last spine 1·25 in the height of the soft dorsal, which is less than that of the spinous. Second anal spine stronger and longer than the 3rd, scarcely as long as the anterior rays, and two fifths higher than the spinous dorsal. Caudal fin rounded. Pectoral very large, extending to above the 2nd anal spine, the width of its base 2.25 in the 5th and longest ray. Ventral reaching to the vent, which is an eye-diameter in front of the anal fin.

Gill-rakers 5 + 9, all but the last lower one tubercular.

Head and body uniform brown, the abdominal region tinged with yellow. Dorsal fin rather lighter than the body, the soft portion with an anterior and posterior median dusky spot; caudal with a broad submarginal dark and a narrow marginal yellowish band, the basal half pale brown; soft rays of anal similar to the caudal, the spines with strongly contrasted alternate blackish and yellow bars; base and terminal border of the pectoral blackish, the intervening portion and the free tips of the rays yellowish; ventral blackish with a yellow tip, the spine similar to those of the anal.

Described from a specimen, 124 millim. long, taken by Mr. James Palmer at Bulwer, and now in the A.F.A.Q. Museum; Cat. No. 1305.

Apistus balnearum sp. nov.

ATKINSON'S FORTESCUE.

D. xv. 9; A. iii. 6 or 7; P. 11 + 1: Sc. 7-60-? L.l. 25. Depth of body 3·35, length of head 2·4, of caudal fin 3, of pectoral 2·3, of ventral 2·85 in length of body. Length of snout 3·25, diameter of eye 5·5, width of interorbit 5·45, length of maxillary 2·5, longest dorsal spine 2·65, longest anal 2·7, detached pectoral ray 2·55 in length of head.

Posterior border of eye nearer to tip of snout than to end of opercular flap; maxillary scarcely reaching to

below anterior border of eye; lower jaw broadly rounded, not fitting into the rostral notch; tip of mandible with a small barbel, from either side of the base of which rises a much shorter one directed outwards; beyond these on each side is a much longer barbel, nearly as long as the eye-diameter. Interorbital region as wide as the eye-diameter, with a short median and two longer and higher lateral ridges in addition to the low supraciliary ridges; occiput with a pair of high sharp arcuate ridges, approaching mesially, and terminating in a spine; preorbital anteriorly with two blunt points, posteriorly with a sharp curved spine; suborbital ridge well developed, smooth but divided into continuous sections, commencing above the base of the preorbital spine and terminating in front of that of the upper preopercular spine; preopercle with a long sharp spine at the angle, and 3 others, which grow increasingly shorter and blunter, below; opercle with three low divergent ridges, the upper of which ends in a small spine at the base of the flap; parietal ridge smooth divided mesially. Head and breast naked; body-scales in regular series; fins naked; lateral line straight.

Length of soft portion of dorsal fin 2·4 in that of the spinous; 1st dorsal spine equal to or longer than the 14th, which is 1·35 in the 7th and longest; last spine 1·15 in the height of the soft rays, which exceed that of the spinous, and do not extend beyond the base of the caudal. Anal fin as high as the soft dorsal, the 1st spine much shorter than the 2nd, which almost equals the 3rd, and is 1·2 in the longest rays. Caudal fin rounded, the tips of the rays slightly protruding. Pectoral reaching to below the middle of the soft dorsal, the 2nd ray longest; the 2 lower rays simple, the outer of these wholly detached, the inner separated from the branched rays by a broad membranous interspace. Ventrals extending to the base of the 3rd anal spine.

When alive or newly captured these fishes are everywhere black except the caudal and a marginal band of variable width on the soft dorsal and anal fins, which are pure white. Shortly after immersion in formalin solution the black commences to fade, and now, at the expiration of twelve months, the bodies have become pale olive green, only the upper surface and sides of the head and the tubular

scales of the lateral line retaining any semblance of the living colors. The basal portion of the dorsal and anal fins have also faded like the body, but the outer portion, the caudal, the pectorals and the ventrals remain as before.

I am inclined to think that the white fin-markings are a token of immaturity,* since in the largest of my specimens the marginal dorsal and anal bands are greatly reduced in width, and the purity of the caudal fin is marred by black lines and spots, which are more closely segregated near the base and tip.

Described from three examples, measuring from 36 to 40 millim., obtained in the Metropolitan Baths, Brisbane, during May, 1909, by Mr. Richard Atkinson, and kindly presented by him to the A.F.A.Q. ; Cat. No. 1105-6.

EROSA FRATRUM sp. nov.

D. xiv. 7 ; A. iii. 6 ; P. 16 : L.l. 10. Depth of body 2·25, length of head 2·15, of caudal fin 4·2, predorsal length 2·25 in length of body. Length of snout 3.2, diameter of eye 4·1, width of interorbit 2·25, length of maxillary 2·15, last dorsal spine 3·2, last anal 4·75, length of pectoral 1·55, of ventral 2·15 in length of head.

Head about as wide as deep. Upper profile of snout feebly complex and strongly declivous ; diameter of eye 1·25 in the snout and 1·8 in the interorbital region, which is flat ; maxillary extending to a little beyond the anterior border of the eye, the width of its distal extremity 2·7 in that of the interorbit. Bones of the head deeply pitted and ridged ; preorbital with three blunt points on its anterior border ; supraorbitals wider forming the lateral margins of a deep fossa, which contains the distal extremities of the premaxillary processes ; they are united opposite the hinder half of the eyes by a much narrower bony bridge, which separates the frontal fossa from the occipital pit, which is bordered behind by a similar but lower ridge ; parietal armature ending in 3 strong blunt processes, the middle much the largest ; suborbital and preopercular regions very rough, the former with a conspicuous hump, behind which the bony area is greatly

* As is the case with *Euelatichthys niger* (Mertens)=*Diagramma crassispinum* Rüpp.=*D. affine* Gthr., in which the caudal fin remains pure white until the fish has attained a length of at least six inches.

expanded and fan-like; preopercular border with two series of blunt spines, the inner 3 the outer 5 in number; a similar spine behind the angle of the mouth; opercle with 2 high smooth edges, which do not terminate in spines; frontal and occipital pits, cheeks, a small temporal patch, and the upper angle of the opercle covered with smooth naked skin. Upper part of body with a few small papillæ.

Length of soft portion of dorsal fin 2·25 in that of the spinous; 1st dorsal spine lower than the 4 succeeding and equal to the middle spines, beyond which they again increase gradually in height to the last spine, which is the longest and 1·2 in the 5th ray, which extends when depressed well beyond the base of the caudal. Third anal spine longest, 1.5 in the middle rays, which just reach the caudal; the membrane of the last dorsal ray extends to the caudal, that of the anal not so far. Caudal small and rounded; depth of caudal peduncle equal to the eye-diameter. Pectoral fin wide, its basal width 1·4 in its length; 5th ray longest, reaching to the vertical from the vent, the lower rays unbranched. Middle ventral rays equal and longest, extending rather more than midway to the anal.

Uniform dark brown above, pale brown below. Upper surface and sides of head with some scattered pearly spots. Spinous dorsal pale brown with one or two lighter blotches; soft dorsal dark brown with an oblique lighter band directed downwards on its anterior half; anal and caudal yellowish brown with black cross-bars, which frequently branch and cross one another so as to form a lattice-work pattern, the latter also with a dusky base; pectoral with the basal half pale lavender, beyond which superiorly is a blackish blotch, its distal half golden crossed by three narrow black bars, the last of which is marginal; inferiorly the two inner bars anastomose like those of the caudal.* (Named for the Brothers Crouch, to whom I am indebted for this unique specimen.)

Described from a Moreton Bay example, 120 millim. in length, in the A.F.A.Q. Museum; Cat, No. 4.

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* In life the upper surface is rufous brown, shading into pink below.

DACTYLOPTERIDÆ.

EBISINUS PROCNE sp. nov.

D. i, i, v, i, 8; A. 6: C. 3-7-3; P. 33 or 34; V. 5: Sc. 49-28. Depth of body 4·85, width of body 4·35, length of head 3·8, of nuchal spine 2·65, of pectoral fin 1·15 in length of body. Width of head 1·85, length of snout 2·75, diameter of eye 3·2, width of interorbit 2, length of maxillary 2·5, of preopercular spine 2 (*ad.*) to 1·35 (*juv.*),* longest dorsal spine 1·4, middle caudal rays 1·3, length of peduncle 1·25, of ventral fin 1·15 in length of head.

Depth of head 1·3 in its width. Snout subvertical and convex, one sixth longer than the eye-diameter; depth of interorbital region 4·85 in its width; maxillary extending to below the anterior border of the pupil. Preopercular spine reaching to above the base of the ventrals in the adult, considerably further in the young. Humeral processes produced to or nearly to the level of the spinous dorsal, the distance between their apices 1·3 in the depth of the intervening notch, which is narrowly rounded anteriorly. Lower edge of posterior part of body with three of the keeled scales enlarged and mobile, the first below the last dorsal rays, the others on the peduncle. Lateral line conspicuous, extending directly† backward to below the middle of the spinous dorsal, thence sweeping downward in a gentle curve to below the origin of the soft dorsal, and finally continuing to the base of the caudal below the 8th series of scaly keels.

Nuchal spine extending to a little behind the spinous dorsal; 2nd detached spine inserted midway between the nuchal spine and the 3rd ray of the spinous dorsal, to the base of which it reaches when depressed; its length is 3·9 in the nuchal spine and 1·4 in the second and longest dorsal spine, which is subequal to the height of the soft dorsal. Anal originating below the 3rd ray of the soft dorsal and much nearer to the root of the caudal than to the gill-opening. Caudal fin subtruncate with the outer rays produced. Width of peduncle immediately behind the dorsal fin 1·4 in its length. Pectoral fin reaching to the middle of the caudal, the tips of all the rays filamentous.

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* In an example 100 millim. long.

† According to the figure given by Jordan and Richardson (Proc. U.S. Nat. Mus., xxxiii, 1908, p. 665) the lateral line is strongly curved upward behind the humeral process in *Ebisinus macracanthus*.

Upper surface pale violet with two broad darker cross bands descending on the sides to the ventral edge: these bands are much more pronounced in the young, growing gradually fainter with advancing age and becoming in large examples merged in the darker tone of the ground color; back prettily blotched and lined with deeper violet and purple: under surface uniform pinkish white or fawn color. Upper surface and sides of head pale yellowish brown spotted with violet; preopercular spine sandy yellow. Free nuchal spine black; detached spine and 1st dorsal dusky; 2nd dorsal and caudal hyaline, the rays with alternate dark and light bands; anal and ventrals like the lower surface, the former with a dark basal blotch between the 4th and 6th rays; pectorals violet, profusely spotted with purple, some of the terminal spots united to form transverse bars. (πρόκνη, a swallow.)

Coast of Eastern Australia, not uncommon.

Described from five specimens, 100 to 390 millim. long, taken in Moreton Bay; type in the A.F.A.Q. Museum; Cat. No. 248.

This species differs greatly from *Ebisinus macracanthus*,* from which it may always be distinguished by the want of the pectoral ocellus.

SOLEIDÆ.

BRACHIRUS SALINARUM sp. nov.

D. 66; A. 53: Sc. 84. Depth of body 2·90, length of head 5·00 in the length of the body. Length of snout 3·00, diameter of eye 8·00, length of right pectoral 2·50 in the length of the body.

Snout projecting well in front of the mouth; upper eye fully one half its diameter before the front of the lower; width of interorbital region one sixth more than the diameter of the eye. Scales on both sides finely ctenoid; no enlarged nuchal scales; lips and under surfaces of snout and interopercle profusely papillose.

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* Jordan and Richardson (*loc. cit.*) wrongly name this species *Ebisinus cheiropthalmus*, the synonymy being as follows:—

Dactylopterus macracanthus Bleeker, Nat. Tijds. Ned. Ind., vii, 1854, p. 449: Celebes.

Dactylopterus cheirophthalmus Bleeker, ibid., p. 494, Banda.

The month's mentioned by those authors refer to the date of writing not of publication, and have, therefore, no scientific value.

Left pectoral nearly as long as the right: ventrals symmetrical, separate from the anal.

The color is now bright green above and below, but there are a few small patches of dark violaceous gray on the eyed side, which may be the true color of the fish in its natural state: outer half of right pectoral black.

Total length of type to base of caudal 123 millim.

Salt pans at Kimberley, North Queensland.

Type in the Queensland Muesum; two mutilated specimens, the caudals and ends of the dorsal and anal fins being broken off.

BRACHIRUS BREVICEPS sp. nov.

D. 72: A. 56: Sc. 75. Depth of body 3·00, length of head 5·50 in the length of the body. Length of snout 3·50, diameter of eye 7·00, length of last dorsal and anal rays 1·15, of caudal fin 1·00, of right pectoral 6·00 in the length of the head.

Snout projecting well in front of the mouth; upper eye about one third of its diameter before the front of the lower; width of interorbital region equal to the diameter of the eye. Scales on both sides ctenoid; no enlarged nuchal scales; lips smooth: a few minute hair-like cirri on the edges of the snout and chin.

Last rays of dorsal and anal fins nearly reaching to the end of the caudal; caudal fin rounded; left pectoral 1·25 in the right; right ventral well separated from the anal: left ventral atrophied.

The specimen appears to have been of a light reddish brown or fawn color, possibly with some lighter spots.

Total length of type 157 millim.

Coast of Queensland at Rockhampton.

Type in the Queensland Museum: a single specimen in bad condition.

BRACHIRUS ASPILOS (Bleeker).

D. 67; A. 52: Sc. 105. Depth of body 2·25, length of head 4·80 in the length of the body. Length of snout 3·00, diameter of eye 7·00, length of last dorsal and anal rays 1·60, of caudal fin 1·50, of right pectoral 2·60 in the length of the head.

Snout projecting well in front of the mouth; upper eye about one third of its diameter before the front of the

lower; width of interorbital region 1·30 in the diameter of the eye. Scales on the right side ctenoid, on the left side cycloid; no enlarged nuchal scales; many of the scales on the colored side with an elongate cutaneous appendage, some of which may be longer than the eye; lips and entire lower surface of head profusely papillose.

Last rays of the dorsal and anal fins nearly reaching to the end of the caudal; caudal fin broadly rounded; left pectoral 1·60 in the right; ventrals asymmetrical, the left much the smaller, separate from the anal.

Uniform blackish,; dorsal, caudal, and anal fins narrowly, right ventral broadly tipped with yellow; right pectoral black.

Total length 360 millim.

Malay Archipelago, from Singapore eastward to North Australia.

Described from a specimen measuring 230 millimeters, and taken at Croker Island, Northern Territory, by Mr. John Colclough, who presented it to the A.F.A.Q. Museum; Cat. No. 1029. The body of this example is much mutilated as if by repeated stabs of a knife or spear.

Synaptura aspilos Bleeker, Nat. Tijds. Ned. Ind., iii, 1852, p. 74: Singapore—id., Verh. Batav. Gen., xxiv, 1852, Pleuron., p. 29—Günther, B. M. Catal. Fish., iv, 1862. p. 482.

Synaptura marmorata Bleeker, Nat. Tijds. Ned. Ind., v., 1853, p. 90: Solor—Günther, ibid.

Synaptura heterolepis Bleeker, Act. Soc. Sci. Ind. Neerl., i, 1856, Amboina, p. 65—Günther, ibid.

Brachirus heterolepis Bleeker, Atlas Ichth., vi, 18, p. 20, pl. ccxxxvi, fig. 2 (juv.) and ccxxxviii (ad): Timor; Batchian; Ceram.

NOTE.—*Synaptura cinerea* (De Vis) is identical with *S. nigra* Macleay. This species rarely shows a few small cutaneous appendages on the back.

CYNOGLOSSUS SINDENSIS Day.

Cynoglossus sindensis Day, Fish, India, 1877, p. 434: *Sind*.—Jordan and Richardson, Bull. Bur. Fish., xxvii, 1907, p. 281: Manila.

D. 108; A. 84; C. 12; V. 4; Sc. 102; L. tr. 7-9-24 = 50. Depth of body 3·75; length of head 4·65 in

length of body. Length of snout 2·80, diameter of eye 9·00, length of caudal fin 2·25 in length of head.

Head as deep as long; cleft of mouth extending to below the hinder border of the lower eye, its angle midway between the tip of the snout and the margin of the opercle lips smooth: rostral hook reaching well beyond the maxillary symphysis. Lower nostril tubular, situated close in front of the inferior border of the lower eye; upper nostril an open longitudinal slit between the eyes. Eyes equal, the upper about half a diameter in advance of the lower; interocular region 1·75 in the eye-diameter.

Scales of colored side ctenoid, those of the head and along the bases of the vertical fins more strongly so than elsewhere; scales of blind side smooth; postocular scales not or scarcely smaller than those of the body. Two lateral lines on each side, the lower straight, along the middle of the body, forking in front of the caudal fin, along which both branches extend; the upper following the curvature of the back almost to the base of the caudal on the colored, not nearly so far on the blind side: both lines extend forward on the head nearly to the end of the snout, where they meet at a rounded angle, thence passing downward to the level of the mouth, where it bends inward and again divides, one branch being continued on to the rostral hook, the other curving abruptly upward and ceasing in front of the interorbital region: the two main lines are also united by a transverse line above the opercle, and a short distance beyond this branch a second subsidiary branch disconnects from the lower line and extends downward to the upper angle of the preopercle, from whence it bends abruptly backward to the border of the opercle, along the outer edge of which it passes to within a short distance of the ventral profile, where it recurves forward to the lower limb of the preopercle, and from thence, forming a rectangle, sweeps downward and forward to the lower lip.

Dorsal fin originating on the snout in front of the upper eye. Caudal fin pointed. Ventral higher than long, not continuous with the anal.

Blue-gray, shading into pale brown posteriorly; opercular region darkest; edges of body above and below yellowish. Dorsal, anal, and ventral fins pale blue tipped with gray; caudal pale brown.

Total length 210 millim.

From the coast of Sind to the Philippines and Northern Australia.

Described from a specimen, 195 millim. long, taken by Mr. John Colclough at Croker Island, Northern Territory, and presented by him to the A.F.A.Q. Museum; Cat. No. 994.

Of the 46 species of *Cynoglossus*, the descriptions of which I have been able to consult,* six only are provided with a pair of lateral lines on each side. These are as follows :—

a. Scales ctenoid on both sides.

1. *kaupii* Bleeker, Act. Soc. Sci. Ind. Neerl., viii, 1860, Sumatra 8, p. 73.

aa. Scales ctenoid on the eyed, cycloid on the blind side.

2. *diplasios* Jordan & Evermann, Proc. U. S. Nat. Mus., xxv, 1902, p. 367 : Formosa—Interlinear scales 14.
3. *bilineatus* Lacepede,† Hist. Nat. Poiss., iv., 1802, pp. 659 and 663 : Indian Seas—Interlinear scales 14 or 15.
4. *dispar* Day, Fish. India, pt. 3, 1877, p. 434: Bombay—Interlinear scales 18 or 19.
5. *sindensis* Day, ibid. : Sind—Interlinear scales 19 or 20.

aaa. Scales cycloid on both sides.

6. *dubius* Day, Journ. Linn., Soc., xi., p. 525.

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* Eleven species are described in works not available to me. Of these a South African species has been named *C. brachycephalus* by Dr. Gilchrist, but this name, having been previously utilized by Bleeker for a Sumatran species, is inadmissible, and may appropriately be altered to *C. gilchristi*, after its discoverer.

† Lacépède's name was altered by Bleeker to *quadrilineatus*, presumably to avoid confusion with *Plagusia bilineata*, and his example has been followed by Günther, Day, and others ; this course, however, is not only unnecessary but absolutely subversive of the code of zoological nomenclature, since Lacépède described the fish which is here called *C. bilineatus* as *Achirus bilineatus*, and, there being no other species of that name, his specific name passes unquestionably on to the *Cynoglossus*.

PTEROPSARIDÆ.

CHILIAS* gen. nov.

Body elongate and fusiform. Scales with longitudinal striæ. Tubes of lateral line short and simple, occupying the basal half of the exposed surface of the scale. Head depressed; cleft of mouth small; lips very thick and wide. Lower jaw without villiform teeth, with two strong hooked canines at the outer angle on either side. Eyes superior, close together. Dorsal fin continuous, with 5 spines, the 4th longest: ventrals inserted below the base of the pectorals. Otherwise as in *Parapercis*.

Coast of Southern Queensland.

Type *Percis stricticeps* De Vis.

The most notable characters in this proposed new genus are the depressed head, approximate orbits, and position of the ventrals.

Up to the present time only three species of pteropsarids have been captured in the seas of Queensland, but it can only be a matter of time before four other species are recorded; they are as follows:—

1. PARAPERCIS NEBULOSA (Quoy and Gaimard), Voy. Uranie, Zool., 1824, p. 349 = *Percis emeryana* Richardson, 1842 = *Percis coxii* Ramsay, 1883 = *P. concinna* De Vis, 1884. Coasts of intertropical and juxtatropical Australia, ranging southward at least as far as Port Jackson.
2. PARAPERCIS CYLINDRICA (Bloch), Ausl. Fisch., vi, 1792, p. 42, pl. ccxcix, fig. 1. China Seas to North-Eastern Queensland (Murray Island, Torres Straits and Dunk Island),† and Lord Howe Island.
3. *Parapercis hexophthalma* (Ehrenberg) Cuvier and Valenciennes, Hist. Nat. Poiss., iii, 1829, p. 271. Red Sea to the Louisiade Archipelago.
4. *Parapercis tetracantha*‡ (Lacépède), Poiss., iii, 1802,

* χεῖλος, lip, with the affix ιας,; in allusion to the abnormal development of the lips.

† Since writing the above, I have received a fine specimen from Moreton Bay.

‡ The name is misleading since the species has, as is usual in the genus, 5 spines in the 1st dorsal fin; nevertheless Lacépède's failure to enumerate the spines correctly does not confer on any subsequent author, any more than on himself, authority to change the name; much less does it permit of the use of the same name for a distinct species.

pp. 473 and 488=*Percis cancellata* Cuvier and Valenciennes, ibid., p. 268. East Indian and Louisiade Archipelagos.

5. *Parapercis clathrata*: nom. subst. for *Percis tetracanthus* Lacépède, ibid., iv. 1803, pp. 285 and 302: inadmissible on account of the preceding species.

6. *Parapercis ocularis* Waite, Mem. Austr. Mus., ii, 1899, p. 109, pl. xxiv: Coast of New South Wales in from 30 to 84 fathoms.

7. CHILIAS STRICTICEPS (De Vis), Proc. Linn. Soc., N.S. Wales, ix, 1884, p. 545. Southern Queensland (Southport; Peel Island and Bulwer, Moreton Bay).

CHILIAS STRICTICEPS (De Vis).

D. v 21; A i 18; P. 17: Sc. 6-62-13. Depth of body 6·1, of caudal peduncle 11·4, length of head 3·4 in length of body. Length of snout 2·65, diameter of eye 5, width of interorbit 3, height of soft dorsal 2·35, of anal 2·65, length of middle caudal rays 1·8, of pectoral fin 1·45 in length of head.

Snout broadly rounded, its upper profile flat; upper lip very wide, more than half the eye-diameter; maxillary not extending to the vertical from the eye; lower jaw bluntly pointed, much longer than the upper. Upper jaw with a broad band of villiform teeth and an outer series of strong conical teeth; a patch of conical teeth on the head of the vomer. Eye superior, well elevated above the surface of the head, its diameter rather more than the width of the preorbital; interorbital region flat. Preopercle entire; opercular spine small and sharp; tip of subopercle serrated.

Spinous dorsal originating a little behind the base of the pectoral; 4th spine longest, as long as the eye; 1st spine minute; membrane of last spine fully attached to the 1st ray; last ray not differentiated. Anal originating below the 5th dorsal ray. Caudal rounded, the upper rays slightly produced. Pectoral extending to above the origin of the anal. Ventral a little shorter than the pectoral; 4th ray longest, reaching to the anal.

Lilac, clouded above with brown, so as to form about seven broad blotches indistinctly separated by lighter interspaces; a lilaceous band bordered below by a dark

brown bar and crossed at regular intervals by eight similar bars from the base of the pectoral to the caudal ; lower half of the sides with nine vertical brown bands, as wide as the interspaces and gradually fading into the lemon yellow of the lower surface ; each of these bands is divided mesially by a narrow black bar, which is continued across the interspaces by dusky spots. Nape and upper surface of the head lilac spotted with brown ; a violaceous bar from the middle of the eye, through the nostrils to the edge of the snout, which is spotted throughout with lilac ; middle of snout with five spots arranged like an arrowhead, the shaft being formed by two spots on the interorbital region ; a vertical violet bar preceded by a triangular spot below the eye ; lips with broad violet bars, those of the lower continued across the chin by a pair of large violet spots ; opercles brown-spotted ; subopercular and branchiostegal regions crossed by two wide violet bands ; a series of six violet spots across the throat immediately behind the gill-openings. Dorsal and anal fins hyaline ; spinous dorsal with the base dark brown and with a few smoky brown spots on the membrane above ; soft dorsal with three small black spots between each ray ; anal with a much larger black basal spot similarly placed ; base of caudal dark brown ; rest of fin partly pale brown partly hyaline, black-spotted, the middle rays tipped with black ; pectorals and ventrals lilac, the former with a violaceous base (*strictus* constricted ; *ceps*, head).

Type in the Queensland Museum.

Length to 180 millim.

Moreton Bay District, Queensland.

Described from a fine example, captured off Peel Island by Mr. T. Welsby, and now in the collection of the A.F.A.Q. ; Cat. No. 870.

Percis stricticeps. De Vis, Proc. Linn. Soc. N.S. Wales, ix, 1884, p. 545.

BATRACHOIDIDÆ.

CORYZICHTHYS GUTTULATUS sp. nov.

D. iii, 20 or 21 ; A. 15 or 16. Length of head 2·8, of caudal fin 4·5, of pectoral 5·2 in length of body. Diameter of eye 3·9, width of interorbit 7, length of ventral 1·85 in length of head.

Head as wide as long. Snout short 1·35, interorbital width 1·75 in the eye-diameter. Teeth as in *C. diemensis*, but without the enlarged ones on the vomer. Two opercular and two subopercular spines, the upper in each being much the larger. Skin of head and body, except the throat and abdomen, covered with more or less reticulated folds. Tentacles moderately developed, those surrounding the jaws simple or bifid in front, much longer and fringed behind, ; a series of broad simple or fringed tentacles round the edges of the opercular bones ; 3 well developed, usually fringed, supraciliary tentacles, the middle the largest ; a small fringed frontonasal tentacle ; 6 longitudinal series of small tentacles on the occiput, extending backward to below the 1st dorsal ; tentacles of the lateral lines very small or absent.

Caudal and pectoral fins rounded ; outer ventral ray scarcely longer than the pectoral.

Brown above, more or less blotched with lighter posteriorly, the lighter parts profusely dotted ; tail with two broad dark transverse bands more or less freckled with lighter ; lower surface light yellowish brown closely dappled with dark brown. Dorsal, anal, and caudal fins dark brown, variously streaked with lighter ; pectorals brown with darker dots ; ventrals brown edged with lighter spots.

Described from three Aru Island examples, 110 to 160 millim. long, in the A.F.A.Q. Museum ; Cat. No. 991.

CALLIONYMIDÆ.

CALLIONYMUS GROSSI sp. nov.

D. iv, 9 ; A. 8 ; P. 17. Depth of body 9·6, width of body 5·5, length of head 4·5, of 1st dorsal spine 1·7, of caudal fin 2·66 to 3·5, of pectoral 4·25, of ventral 3·45 in length of body. Depth of head 2·2, width of head 1·15, diameter of eye 3, length of snout 2·6, of preopercular spine 2.5, of last dorsal ray 1·1, of last anal 1·5 in length of head.

Body gently rounded above, its greatest depth below the anterior dorsal rays. Snout about as wide as deep, pointed, its depth 1·15 in it length ; eyes close together directed upward, prominent, 1·2 in the snout, and 2·6 in the width of the head. Preopercular spine straight, the

inner edge with 7 to 9 subequal antrorse serrluæ,* the outer with a strong denticle directed forward near its base. Occiput covered with smooth skin. Lateral line median and conspicuous.

Origin of spinous dorsal somewhat nearer to soft dorsal than to tip of snout; spinous dorsal high, the first spine terminating in a filament, which extends to the last ray of the soft dorsal; the other spines not filamentous, the membrane of the last, which equals the last ray, not quite reaching the soft dorsal, the base of which is somewhat longer than its distance from the tip of the snout; last ray longest, extending slightly beyond or not quite to the base of the caudal. Anal originating below the 2nd dorsal ray, its base less than its distance from the tip of the mandible; last ray not nearly reaching so far back as that of the soft dorsal. Caudal peduncle distally fusiform, its least depth 1·3 in the eye-diameter. Pectoral inserted below the posterior half of the spinous dorsal, the middle rays longest, extending to below the 3rd or 4th dorsal ray. Ventral reaching beyond or not quite to the origin of the anal.

Gill-openings superior, opposite to the origin of the dorsal, further apart than the outer borders of the eyes, and midway between the eye and the pectoral fin.

Golden brown above, dull yellow below, the throat and ventral region silvery; back and sides above the lateral line with numerous lilac annuli about as large as the gill-opening, and often crowded together so as to form clusters of considerable size; some of the annuli have a blackish central dot; a broad dusky band across the peduncle; an irregular series of dark brown spots along the middle of the side just below the lateral line. Upper eyelids and occiput blackish. Spinous dorsal violet, with oblique wavy lilac dark-edged cross-bands, the anterior spine and its filament blackish; soft dorsal and anal yellowish gray, the former with three series of oblong violet spots, the membrane of the last ray of the latter clouded; upper

* The armature of the preopercular spine is so imperceptibly graduated between a single strong recurved spinule and fine serrulæ that I cannot see my way, in the absence of additional characters, to admit *Calliurichthys* Jordan & Fowler (Proc. U.S. Nat. Mus., xxv, 1903, p. 941) as a valid genus or even a well marked subgenus.

portion of caudal yellow spotted with brown, lower portion violet with a paler margin; pectorals dull yellow, immaculate; ventrals yellowish, the ground color almost wholly obscured by violet dots, among which are scattered numerous white dark-edged ocelli, and, near the tip, a few blackish spots. A second specimen (? ♀) differs in being of a general darker coloration above, the clear golden brown being replaced by violaceous brown, which color extends further down the sides, somewhat obscuring the lateral series of spots and terminating inferiorly in 12 or 13 short blunt processes, which encroach upon the pure white of the under parts. The fins correspond in general pattern with those of the larger example, but the cross-bands on the spinous dorsal are indistinct, and the pectorals are gray, their rays alternately banded with gray and lilac. (Named for my friend and colleague, the late Major George Gross, one of the leading conchologists of Queensland.)

Described from two Moreton Bay specimens, measuring respectively 128 and 112 millim., in the collection of the A.F.A.Q.; Cat. No. 958.

CALLIONYMIDÆ.

DACTYLOPUS, Gill.

Body subcylindrical. Lateral line single, superior, straight. Head triangular, not depressed, the snout moderate and anteriorly declivous. Mouth small and subinferior; upper jaw the longer; lower lip expanded to form a small lobe on each side. Teeth long, slender, and slightly recurved anteriorly, shorter, stouter and hooked laterally. Eyes well separated, superolateral. Preopercular spine well developed, strongly armed above and below. Spinous dorsal originating well in advance of the gill-opening, the last spine without membrane; soft dorsal high, all the rays except the first branched; caudal fin graduated above, rounded below; pectoral fin angular, with 18 rays, the two outer above and below simple: ventral much longer than the pectoral, with i 1+4 rays, the last the longest, the spine and the outer ray free. Branchial foramen moderate, lateral.

From the Molucca Seas to the East Coast of Australia. Monotypic.

There is a remarkable resemblance in some of the generic characters between *Dactylopus* and the rare Japanese

Callionymus altivelis Schlegel. In both the branchial foramen is lateral and below the first dorsal, the last dorsal spine is unattached by membrane to the back, and the soft dorsal is very high and has all the rays except the first branched. *Dactylopus*, however, differs materially in the increased armature of the preopercular spine and in the presence of a free ventral ray.

Dactylopus Gill, Proc. Acad. Nat. Sci. Phila., 1859, p. 130 (*bennetti*=*dactylopus*).

Vulsus Günther, B.M. Catal. Fish., iii, 1861, p. 15 (*dactylopus*).

DACTYLOPUS DACTYLOPUS (Cuvier & Valenciennes).

D. iv,—8; A. 7; P. 18. Depth of body 6·20, width of body 4·50, length of head 3·50, of first dorsal spine 1·15 to 1·50, of caudal fin 2·15 to 2·60, of ventral 2·00 to 2·50 in length of body. Depth of head 1·70, width of head 1·15, diameter of eye 3·60, interorbital width 8·85, length of snout 2·90, of preopercular spine 3·30, of last dorsal ray 1·05, of last anal ray 1·20 in length of head.

Body rounded above, its greatest depth below the anterior dorsal rays. Snout as wide as deep, obtusely pointed, its depth 1·25 in its length. Eyes separated by a deep concavity, the supraorbital ridges high and sharp, extending forward on the snout, the diameter 1·30 in the snout and 3·00 in the width of the head. Maxillary extending to below the anterior border of the eye. Preopercular spine strong and acute, its distal extremity slightly curved inward; outer border with four graduated barbs, the anterior median, very strong, and directed forward, the posterior reduced to a mere tubercle rising from the base of the curve; inner border with three curved subequal antrorse barbs. Occiput with a pair of raised bony bucklers, covered with reticulated sculpture, and separated by a smooth fossa, which is a continuation of the interorbital groove. Gill-openings lateral, opposite the middle of the spinous dorsal, as far apart as the head in front of the hinder margin of the eye, and about twice as far from the eye as from the pectoral fin. Lateral line well defined in front, less so behind, terminating well above the middle of the base of the caudal.

Origin of spinous dorsal a little nearer to the soft dorsal than to the tip of the snout; spinous dorsal high,

the three anterior spines terminating in long slender filaments, which extend backward to well beyond the base of the caudal (♂) or to the peduncle (♀); last spine without membrane, much shorter than the rays; interdorsal space as long as the spinous dorsal: soft dorsal high, the rays but little graduated to the last, which reaches to or slightly beyond the base of the caudal; base of soft dorsal equal to its distance from the anterior border of the eye. Anal originating below the membrane of the third dorsal ray, similar to and nearly as high as the second dorsal, its base about half its distance from the tip of the mandible, its last ray reaching as far back as that of the soft dorsal. Caudal fin with rounded tip; caudal peduncle distally compressed, its least depth equaling the eye. Pectoral fin inserted below the end of the spinous dorsal, the middle rays the longest, extending to below the fourth dorsal ray. Free ventral ray as long as the head without the snout, much longer than the succeeding ray; continuous rays graduated, the last very large, reaching beyond the pectoral, its membrane attached superiorly to the base of the eighth pectoral ray.

Olive-or violet-brown above, with six large blackish blotches across the back, the interspaces with darker freckles and sometimes with blue black-edged ocelli of variable size; sides with a similar number of somewhat stellate blotches, more or less corresponding to the spaces between the dorsal blotches, the interspaces chestnut or violet, with or without golden or pearly spots and reticulated lines; lower surface white, faintly tinged with bluish; under surface of head pale brown. Iris silvery, with an inner golden rim. Spinous dorsal and its filaments blackish, the membrane of the second ray with numerous small pearly spots on its outer half, that of the third with a wide lighter marginal band; second dorsal lilac, the ground color well nigh obliterated by crowded oblique purplish bars: base of anal rufous brown, deepening to purple at the margin: caudal fin golden, the rays brown, speckled with pale blue; posterior margin with wavy blue transverse streaks, the rest of the fin except the two lower rays which are smoky brown, with elongate blue lines, which are oblique above and horizontal below; pectorals hyaline, the basal half of the upper and middle rays with alternate lilac and

rufous rings: free ventral ray with alternating rings of gold and purple, the united rays blackish or dark olive-green, with one or two large pearly basal spots.

In the female the membrane of the spinous dorsal is golden brown, with darker marblings and irregular light blue spots and short bands; basal two thirds of soft dorsal with elongate dark brown blue-edged spots between the rays, the marginal third more faintly banded but profusely freckled with blue: inner third of anal golden brown with elongate pearly spots, the rest of the fin smoky, with dark blue black-edged spots and lines.

Total length 156 millim.

From the Molucca Seas to South-Eastern Queensland (Stradbroke Island and Wynnum).

Described from a fine Moreton Bay example in the A.F.A.Q. Museum: Cat. No. 684.

Callionymus dactylopus (Bennett) Cuvier and Valenciennes, Hist. Nat. Poiss., xii, 1837, p. 310—Bleeker, Nat. Tijds. Ned. Ind., iii, 1852, p. 559: Amboina.

Dactylopus bennetti Gill, Proc. Acad, Nat. Sci. Phila., 1859, p. 130. Name only.

Vulsus dactylopus Günther, B.M. Catal. Fish.. iii, 1861, p. 152: Amboina; Celebes.

Dactylopus dactylopus Ogilby, Ann. Queensl. Mus., No. 9, 1908, p. 38: Moreton Bay.

Note.—Callionymus achates De Vis (Proc. Linn. Soc. N.S. Wales), is founded on a female of *C. calauropomus*.

BLENNIIDÆ.

Petroskirtes furtivus (De Vis).

D. xii, 21 or 22; A. i 23 to 25; C. 13; P. 13; V. 2. Depth of body 5·6, length of head 5, of anal fin 2, of middle caudal rays 5·75, of pectoral fin 5·1, of ventral 5·1 in length of body. Length of snout 3·75, diameter of eye 3·85, width of interorbit 9·5, longest dorsal ray 1·35, longest anal 1·85, depth of peduncle 2·3 in length of head.

Head obtusely rounded in front, its width 1·5, its depth 1·15 in its length; snout short and blunt; upper jaw the longer; interorbital region convex; cleft of mouth extending to below the anterior border of the eye. Dentition—I. $\frac{24}{24}$; C. $\frac{2}{2}$; upper canine strongly hooked,

about half tne length of the lower. Lateral line consisting of 2 short tubes.

Dorsal fin originating slightly in advance of the gill-opening, the rays gradually increasing in length to the middle of the soft portion, the longest articulated ray 1·25 time the height of the last spinous ray; membrane of last ray reaching to the base of the caudal fin. Anal originating below the 11th dorsal spine. Caudal fin rounded, the 3rd to 5th and 9th to 11th rays in the male terminating in a filament. Pectoral fin rounded, the 8th and 9th rays longest, not reaching to the vertical from the vent. Ventral fin long, the inner ray as long as the pectoral.

Gill-opening directed forward from above the base of the pectoral, its width 5 in the head. Vertebræ 11 + 31 = 42.

Yellow closely powdered with dusky dots; a broad dark blue band from the eye to the gill-opening, continued along the middle of the body as a much paler and rather ill defined band, which becomes forked below the middle of the soft dorsal, the lower branch being usually broken up into a series of spots, and both being continued well on to the caudal fin; behind the pectoral fin the lateral band throws off 6 or 7 conspicuously darker offshoots, which are directed downward and slightly backward; a row of blue spots along the base of the dorsal fin; abdominal region sometimes crossed by a few narrow dark lines. Head pale olivaceous brown, the cheeks with 2 or 3 darker vertical bars; lower portion of the opercular, the branchiostegal, and the jugular regions closely spotted with blue. Teeth tipped with tawny yellow. Dorsal fin violet, the spinous portion the darker and with two series of pale spots, the soft portion with several narrow dark lines commencing at the base and running obliquely backward; free tips of soft dorsal and anal rays white; an oblong blackish inframarginal spot on the 4 middle rays of the soft dorsal in the adult; anal lilac; pectoral and ventral pale yellow, the former with a few small round spots on or near the base.

Female.*—Differs in having the lateral band more

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* The female bears a remarkable resemblance to the Japanese *Petroskirtes elegans* as figured by Jordan and Snyder (Proc. U.S. Nat. Mus., xxv, 1903, p. 454, fig. 6).

indistinct and ceasing altogether before the middle of the tail, the posterior half of which is adorned with numerous small blue spots; the dark band behind the eye is usually broken up in two oval or lunate spots; all the fins are uniform gray except the spinous dorsal, which has a basal series of dusky spots.

This pretty little blenny is an inhabitant of the East Coast of Australia from Port Jackson to the Wide Bay District, beyond which points it has not yet been traced though it doubtless occurs. It is exceedingly abundant on all the rocky sections of the foreshores and islands of Moreton Bay, where it is one of the most common objects of the rock-pool fauna. In the Great Sandy Strait I found it scarce, the environment probably being unsuitable to its habits.

Described from 10 specimens, 45 to 85 millim. long, in the A.F.A.Q. Museum; Cat. Nos. 71 and 1145.

Petroscirtes fasciolatus Macleay, Proc. Linn, Soc. N.S. Wales, vi, 1881, p. 8: Port Jackson (male). Not *Omobranchus fasciolatus* Ehrenberg = *Blennechis fasciolatus* Valenciennes, 1836.

Salarias furtivus De Vis,* Proc. Linn. Soc. N.S. Wales, iv, 1884, p. 697: St. Helena, Moreton Bay.

Petroscirtes macleayi Ogilby, Catal. Fish. N.S. Wales, p. 38, 1886. Substitute for *P. fasciolatus* Macleay preoccupied.

PETROSKIRTES JAPONICUS Bleeker.

D. xii 22; A. i 22; C. 13; P. 13; V. 2. Depth of body 6·25, length of head 5·35, of anal fin 2·1, of caudal 6·2, of pectoral 5·4 in length of body. Length of snout 3, diameter of eye 4·25, width of interorbit 9·25, longest dorsal ray 1·45, of ventral 9·35, longest anal 2·05, depth of peduncle 2·15 in length of head.

Head rounded in front, its width 1·5, its depth 1·25 in its length; no nasal nor orbital tentacles; male with a low cutaneous occipital crest; cheeks swollen. Snout short and blunt; upper jaw the longer; both lips posteriorly with pendent flaps; eye small; interorbital region convex;

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* The author cannot, without demur, admit the accuracy of some of Mr. De Vis' earlier descriptions, and finds himself compelled to class most of the species of *Salarias* described by Mr. De Vis, as belonging to the genus *Petroskirtes*.

cleft of mouth extending to below the anterior border of the eye. Dentition—I. $\frac{28 \text{ to } 36^*}{30 \text{ to } 38}$; C. $\frac{2}{2}$; lower canines much the longer. Lateral line incomplete, consisting of about 6 tubes, and ceasing nearly above the tip of the appressed pectoral.

Dorsal fin originating above the base of the pectoral, the rays increasing in length to the 3rd, beyond which they are subequal, ; longest articulated rays behind the middle of the soft fin and 1·5 time the height of the last spinous ray ; membrane of last dorsal ray extending slightly beyond the base of the caudal. Anal fin originating below the 2nd dorsal ray. Caudal fin rounded. Pectoral rounded, the 8th ray longest, not nearly reaching to the vertical from the vent. Ventral short, the inner ray slightly the longer.

Gill-opening in front of and above the base of the pectoral, its width 5·5 in the head. Vertebræ $11+29=40$.

Olive-green, darkest anteriorly, the lower surface tinged with yellow ; trunk with 3 to 5 horizontal bars, which disappear above the vent ; the upper, however, is continued as a series of distant spots to below the middle of the soft dorsal, and along the middle of the tail there is a series of spots or vertical bars extending to the caudal fin. Head with 3 faint vertical bands, which meet across the under surface, where they show distinctly on the lighter ground. Fins violaceous, the tips of the anal rays white.

This blenny has been recorded from the coasts of Eastern Australia and Southern Japan, and attains a length of 110 millim. The remarks under the preceding species apply with equal force to this, which is not, however, so numerous. I obtained one specimen only in Great Sandy Strait, and one, an exceptionally fine example, at Woody Point, Moreton Bay.

Described from 6 specimens measuring from 62 to 110 millim., among these being Mr. De Vis.' types. Cat. Nos. in A.F.A.Q., 907 and 1123.

Petroskirtes japonicus Bleeker, Versl. en Med. Kon. Akad. Wetens., iii, 1869, p. 246, c. fig. : Jedo Bay, S.E. Japan.

* The incisors increase in number with the age of the fish ; Jordan and Snyder give "26 to 28" as the formula of *P. dasson*, Bleeker "36 to 40" as that of *P. japonicus*.

Salarias helenæ De Vis, Proc. Linn. Soc. N.S. Wales, ix, 1884, p. 697: St. Helena, Moreton Bay.

Aspidontus dasson Jordan and Snyder, Proc. U.S. Nat. Mus., xxv, 1903, p. 456, fig. 8: Wakanoura and Shima, S. Japan.

Aspidontus japonicus idd., ibid., p. 458.

PETROSKIRTES ANOLIUS (Cuvier and Valenciennes).

D. xii 17 or 18*; A. i 20 or 21; C. 13; P. 13; V. 2. Depth of body 4·85, length of head 4·66, longest dorsal ray 2·8, length of anal fin 1·9, of caudal 4·65, of pectoral 4·6, of ventral 4·5 in length of body. Length of snout 3·75, diameter of eye 4, width of interorbit 8, longest anal ray 2, depth of peduncle 2·65 in length of head.

Head subvertical in front, its width 2, its depth (without crest) 1·20 in its length; no nasal nor orbital tentacles; an elevated rounded cutaneous crest extends from before the upper border of the eye nearly to the dorsal fin, its height equal to the eye-diameter; cheeks not swollen. Snout short and somewhat pointed; jaws subequal; lower lip posteriorly lobate; eyes small; interorbital region convex; cleft of mouth extending to below the posterior border of the eye. Dentition—I. $\frac{24}{24}$; C. $\frac{2}{2}$; lower canines much the larger. Lateral line curved upward anteriorly, consisting of from 8 to 10 tubes, and ceasing below or before the last spinous dorsal ray.

Dorsal fin originating a little in advance of the base of the pectoral, the spinous rays subequal in length, the soft gradually increasing in length to the 6th; 7th to 13th rays produced and filamentous, about 4 times as long as the last spinous ray; membrane of last ray scarcely extending to the base of the caudal. Anal fin originating below the 11th dorsal spine. Caudal rounded. Pectoral rounded, the 9th ray longest. Ventral well developed, the inner ray the longer.

Gill-opening in front of and above the base of the pectoral, its width about 6 in the head.

* In his description of *P. wilsoni* Macleay gives the dorsal fin formula as "26" (*i.e.* xii, 14); of the score or so of specimens which I have examined from different localities none showed a greater variation than that given above; it would therefore be well for one of my Sydney co-workers to recount the dorsal rays in the type.

Head and body chestnut brown or olive-green, the latter with numerous indistinct darker angulated transverse bars, which cease below the middle of the soft dorsal; rest of tail with 3 darker longitudinal bars and some scattered black spots. Head sometimes with one or two vertical silvery streaks and a dusky cheek-spot. Dorsal fin brownish olive, darkest anteriorly, the spinous portion with 3 or 4 oblique darker bars, the soft immaculate; anal fin orange brown, each ray with a basal, median, and terminal sky-blue spot; caudal orange; pectoral greenish olive with a large round dusky spot on its muscular base; ventrals sky-blue. After immersion in formalin solution for some time these fishes become uniform blackish brown. (*Anolius*; a genus of American lizards, the head of which suggests a resemblance*).

The "Crested Blenny" or "Oyster Blenny," as it may with propriety be called, is a resident of the coasts of New South Wales and Southern Queensland, and grows to a length of 70 millim.

The life history of this little creature, so far as it has been determined, is both curious and interesting. Apparently they mate at a very early age, since in no other way can we account for their presence in places which it is impossible for them either to enter or leave in their adult state. Having paired, the young couple immediately proceed to the choice of a residence; this almost invariably takes the form of a dead oyster-shell, between the valves of which they are able at this stage easily to insert their slim and delicate bodies. In the safe seclusion of this retreat they live out their peaceful lives, undisturbed by the strenuous and ceaseless war of Nature, which rages ever around and above them. Here they are dependent for food upon such small animals as may find their way between the valves of their prison and such flotsam as the tide may drift therein. Here too they breed, the female attaching her eggs by means of some glutinous substance to the upper wall of the shell, and it is remarkable that in all the cases which have come under my notice the ova were deposited not in a single mass but in scattered groups of some half-dozen eggs each; this arrangement may

* "Il relève sa petite tête comme ses petits sauriens nommés anolis dans nos îles." (Cuvier & Valenciennes, loc. cit.).

possibly be selected in order to ensure a freer play of water on each egg. The young, on their emergence from the ova are quickly driven out from the parents' domicile to make their own way in the great world beyond. On one occasion only have I known of a specimen having been discovered otherwise than in an oyster-shell: this individual, which was in a greatly contorted condition, had when young insinuated itself into a rock-crevice so small that, as it increased in size, its body was compelled to adapt itself to the form of its cell, of which it was in fact an animated cast: notwithstanding this disability the fish was in perfect condition, not seemingly having suffered any inconvenience from the distortion of its body. This little blenny has contracted a curious habit, possibly due to inherited instinct consequent on the restricted nature of its normal home environment; when kept alive in a tumbler or even in a basin, it never willingly moves forward in the usual manner of its class, but invariably retrogrades, pushing itself backward by means of its pectoral and ventral fins.

Described from 3 Moreton Bay and one Great Sandy Strait specimens, measuring from 52 to 70 millim., in the collection of the A.F.A.Q.; Cat. Noo. 871 and 1237.

Blennechis anolius Cuvier and Valenciennes, Hist. Nat. Poiss., xi, 1836, p. 288: Port Jackson.

Petroscirtes anolis Günther, B.M. Catal. Fish., iii, 1861, p. 238.

Petroscirtes cristiceps Macleay, Proc. Linn. Soc. N.S. Wales, vi, 1881: Port Jackson.

Petroscirtes wilsoni id., ibid, ix, 1884, p. 171: Port Jackson.

Note.—The Güntherian genus *Petroscirtes* has very properly been broken up in sections by various authors, and with the object of facilitating the identification of species may with advantage be still further subdivided as follows:—

a. Canine teeth in both jaws.

b. Dorsal fin free or just touching the caudal .. .. .. i PETROSKIRTES*

c. Anterior dorsal rays produced (*Petroskirtes*).

c[1]. Anterior dorsal rays not produced.

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* *Petroskirtes* Rüppell, Atlas Fisch. Roth. Meer., 1828, p. 110 (*mitratus*).

d. Soft dorsal rays subequal; occiput smooth or nearly so (*Aspidontus**).

d[1]. Some of the soft dorsal rays filamentous; occiput with an elevated crest (*Cyneichthys*†).

b[1]. Dorsal fin more or less continuous with the caudal .. .. ii. ENCHELYURUS‡

a[1]. Canine teeth in the lower jaw only; mouth inferior .. .. .. iii. MACRURRHYNCHUS§

a[2]. No canine teeth.

e. Mouth terminal .. .. RUNULA‖

e[1]. Mouth inferior .. .. .. RUNULOPS¶

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* *Aspidontus* Quoy & Gaimard

† *Cyneichthys*; nom. nov.; (*anolius*). κυνέη, a helmet; ἰχθύς, a fish.

‡ *Enchelyurus* Peters, Mon. Akad. Berlin, 1868, p. 268 (*flavipes*).

§ *Macrurrhynchus* Ogilby, Proc. Linn. Soc. N.S Wales, xxi, 1896, p. 136 (*maroubræ*).

‖ *Runula* Jordan.

¶ *Runulops*; nom. nov.; founded on two South American species described by Jenyns.

QUEENSLAND'S PLANT ASSOCIATIONS

(Some Problems of Queensland's Botanogeography).

By Dr. **KAREL DOMIN**

(Prague, Czech University).

Read before the Royal Society of Queensland, April 9th, 1910.

There are two stages in our knowledge of the flora of every country. First, of course, it is necessary to know the elements of the flora, to identify and classify all the plants and to ascertain their affinities. All these are found in a flora where in natural system (according to their affinities) all plants occurring in the country are mentioned, accompanied with descriptions and their localities, showing the geographical distribution.

This first step, however, is not sufficient for a complete knowledge of the flora. There are hundreds of questions about the life of single plants and their surrounding circumstances and conditions, which cause the plants to be found in special associations. The material worked out in a flora makes a *foundation* for all these questions, which penetrate deeper into the study of plant-life, being a part of a science called *Botanogeography* or *Phytogeography*.

Botanogeography deals with the adaptation of plants to different surrounding circumstances; it explains which are the plant-associations of the country, and it tries to find out all the reasons which cause the unequal distribution of the different plant-associations. The geographical distribution of single plants is, of course, given in a flora, but without any explanation.

These reasons mentioned above are partly due to circumstances now existing, and partly they are the result of the historical development of the flora. Therefore, the botanogeography must deal not only with the climate,

soil, etc., of the country, but it must also study the evolution of the country and its flora during the past geological periods.

A special part of botanogeography—so-called *ecology*—tries to explain the different adaptations of the plants according to the so-called ecological factors, *i.e.*, especially the soil and the climate (the influence of warmth, water, air).

The flora of Australia (except in some Northern and Central parts) is in its rough outlines fairly well known, although there is an immense field for future botanists. But there is very little done in botanogeography, except a recent work by Dr. L. Diels, dealing with the botanogeography of extra-tropical Western Australia. In Queensland however, until the present time, very little was known about the factors which cause the different plant-associations of the State. We know the elements of the flora (and fairly well the geographical distribution of single plants), due in part to *Bentham*, the author of the "Flora Australiensis," who unfortunately never was in Australia, and was therefore unable to deal with the botanogeography of the country, although his flora—considering all circumstances—is wonderful; further due to the numerous works of *Baron Ferd. von Mueller*, and of *F. M. Bailey*, who devoted his whole life to the study of Queensland's flora, and also due to some other authors, who published valuable special papers and works, as *J. Shirley* (the Lichen-flora of Queensland), *Brotherus* and *K. Mueller* (Mosses), *Cooke* (Fungi), etc.

Knowing all these circumstances, I made a plan for a visit to Queensland, intending to study the botanogeography of the State, as there is no other part of Australia which would be so interesting from the botanical standpoint, and which offers simultaneously marvellous prospects for agricultural development, combining the possibilities of tropical agriculture in the North and especially in the coastal region, and of growing different plants of temperate region in Southern parts. Besides these there is a large area with splendid timbers; many of them are used at the present time, but still more of them are wasted in a manner, which is understood by everybody familiar with the conditions of this wonderful virgin country, but which nobody from Europe can understand.

But let me begin with a short description of the chief plant-associations in Queensland. I cannot afford to speak

in detail, but the result of my studies in different districts of the State will be found in a book, which I hope to publish soon after my return to Bohemia.

The most favourable conditions occur in the so-called *vine scrubs.* They are found in those portions where there is sufficient moisture in the soil and sufficient rainfall. In the North of Queensland, and especially in the coastal region, the conditions for vine-scrubs are much more favourable than in other parts of Queensland, and they extend over larger areas on different soils. They prefer, of course, always a rich, deep soil, especially alluvial and basaltic, but in those portions where the rainfall reaches a very high range, we find them often on a very poor, almost innutritious soil, as on Bellenden Ker or Bartle Frere, on a poor granitic soil.

Where the conditions are less suitable, the vine-scrubs are restricted to narrow belts along the creeks and rivers. These so-called "*gallery vine-scrubs*" are often found far in the dry open-forest country, which is usually unable to bear this plant-association, requiring better soil and especially much more moisture, both in the soil and in the air.

In the Southern part of Queensland the vine-scrubs are usually only on good nutritious soil or near watercourses. The largest area of vine-scrubs is found in the Gympie district (Eumundi, Yandina, etc.), but they are besides this nearly everywhere on the basaltic mountains as far as the Macpherson Range, the border of New South Wales. Here we usually find that the distribution of vine-scrubs coincides with the distribution of basalt. Sometimes the scrubs extend from the basaltic plateaux along the creeks down into the open forest country. In some places, where the basaltic strata are too thin or the moisture insufficient, we find forest instead of scrub. On the rich alluvial soil along the creeks and rivers are also often narrow belts of vine-scrubs. But most of them (at least in Southern Queensland) have disappeared, as they occupied the best agricultural country, and have been cut down.

In the far North of Queensland (as Cape York Peninsula), there are no vine-scrubs extending over big areas, but notwithstanding there are along the creeks and rivers splendid vine-scrubs, some of them very little known, but possessing a rich beautiful flora with many relations to

the Papuan and Malayan regions (I may mention that all Queensland's pitcher-plants are found here, as *Nepenthes Kennedyi*, F. v. M., and seven new species described by *F. M. Bailey*, *i.e.*, *N. albo-lineata*, *Alicae*, *Bernaysii*, *Cholmondeleyi*, *Jardinei*, *Moorei*, *Rowanae*).

The biggest and most marvellous vine-scrubs are found in the coastal districts from Cooktown in the North to Ingham in the South. Townsville itself lies in open forest country, but there are interesting vine-scrubs on Mount Elliot and in many places along the coast southwards.

The vine-scrubs mentioned above reach their best evolution in the Cairns-Geraldton districts, where are the two highest mountains of Queensland, Bellenden Ker and Bartle Frere, both covered with thick jungles. This part of Queensland has a truly tropical character. We find here wonderful scenery, really unrivalled in its glory and its magnificent variations. There are not only the well-known Barron Falls, which with their unique gorge excel in the rainy season, and especially during the floods, the best scenery of the world, but there are everywhere landscapes of such beauty, that I never saw better ones, either in the Malayan Peninsula or in Java or elsewhere in the tropics. This fact is worthy to be mentioned, as there are people in Queensland itself who do not guess the wonders of this virgin country, and who visit other tropics for the same purpose. Besides, this is the district the best suited for tropical agriculture, and a sugar cane district *par excellence*. The climate here, though tropical, is by far more supportable than in the wet tropics, where the temperature in the night often only slightly differs from the disagreeable wet heat during the day.

It would be superfluous in Queensland to give a detailed description of a vine-scrub, besides it was given years ago by *Pettigrew* and some time ago by *Ph. MacMahon*. Vine-scrubs presents always a dense and thick forest association, with very little grass in undergrowth, but with plenty of creepers (vines) and any amount of epiphytic plants on the trunks and branches of the trees. Orchids and ferns are the most numerous among them. There are many peculiarities in the vine-scrubs: the trees attain usually an enormous height, but their bark is regularly thin and their top not too dense. They are sometimes *cauliflor* (producing

the flowers and fruit directly on the trunk or from old leafless branches), and they have on the base of the trunk dilatated flanks.

There are different types of vine-scrubs, as for instance in the biggest scrub district near Cairns there are (except the coastal scrubs) five different types, which appear always under the same (or very similar) conditions and show approximately the same composition. The richest and most marvellous are the vine-scrubs in flats on deep alluvium; this is the proper home of the lawyer cane and the climbing bamboo (*Bambusa Moreheadiana*), the only one known in Queensland. Nearly the whole space between the trees is filled with magnificent creepers climbing from top to top and drooping in wonderful festoons. The trees are here of great size, but their timber is not of such good quality as in the higher positions, for the growth in these warm parts is too quick.

Further on there are three types of vine-scrubs on non-basaltic soil. Each type has its special trees and different characters, but it would take too much time to deal with them. The last type is represented by the splendid vine-scrubs on the basaltic plateaux, as for instance near Atherton, Tolga, Aloomba, and all around both volcanic lakes (Lake Eacham and Lake Barein). The scrubs are here not so crowded with creepers and epiphytic plants, but the trees attain an immense height. Here is without doubt the best timber district, which excels all that I saw in other scrubs of Queensland.

Due to the careful investigations of *J. F. Bailey*, we are familiar with most of the trees in this district. Many of them are just at present used in different sawmills, but there are many others with valuable timbers neglected so far. We find in the sawmills especially the following trees represented:—

Tarrietia argyrodendron and *trifoliata*, very plentiful everywhere in this scrub, known as *Crowsfoot Elm*.

Elaeocarpus sp. div., known as *Quondong*.

Melia composita or *White Cedar* is an elegant tree with soft, light-red wood. It is usually a smaller tree, but plentiful, especially along the clearings.

Synoum glandulosum or *Rosewood* is a moderate sized tree belonging to the same family (*Meliaceae*) and very

plentiful. It is well known also from the scrubs in Southern Queensland.

Cedrela Toona or *Red Cedar*, known near Herberton as "Wanga," is a tall tree of the same family. Its red coloured wood of a beautiful grain is very valuable and much required. This tree is getting scarce.

Flindersia Chatawaiana or *Maple*, again a representative of the Meliaceous plants, is very plentiful and has a nice wood, which is extensively used.

Flindersia Schottiana or *Ash* is also plentiful; it is known under the native name, "Bunji Bunji."

Castanospermum Australe is the well-known Bean Tree; it is plentiful in different types of vine-scrub.

Xanthostemon chrysanthus or *Pender* is very plentiful.

Eugenia hemilampra or *Mahogany* is rather scarce.

Alstonia scholaris or *White Pine*, which is very common in the scrubs on alluvium, is not too plentiful on the basaltic plateau.

Gmelina fasciculiflora or *White Beech* is plentiful, as is *Daphnandra aromatica*, the so called *Sassafras*.

Cryptocarya Palmerstoni or *Walnut* is very plentiful. Its characteristic nuts are to be found everywhere in these scrubs.

Under the name of *Silky Oak* (or Silky Wood), there are known 4 different trees, which are more or less plentiful. They are:—

Darlingia spectatissima
Cardwellia sublimis.
Stenocarpus sinuatus. }
Embothrium Wickhami. }

Agathis Palmerstoni or *Kauri Pine* is rather plentiful and attains an immense size.

Podocarpus pedunculata or so called *Black Pine* is scarce.

Darlingia araliifolia or *Bull Oak* is a very plentiful tree.

Blepharocarya involucrigera or *Bally Gum* is very plentiful also.

A different type of vine-scrub is often found in a belt along the coast. I use only for these scrubs the name, "*Coastal Scrubs*." The trees growing here are not only botanically different, but differ also in their ecology, as

they are in harmony with the special conditions on the sea-coast. A strong wind usually blows here, the trees are richly branched, with very hard horizontal branches and often with a dense top. The leaves are usually very coriaceous, and epiphytic plants are not too numerous. We find this type of scrub both in North and South Queensland.

Dealing with the sea-coast we may mention the other plant-associations found here. On the salt-water swamps along the coast, but only in sheltered positions, and along the rivers as far as the tide reaches, are usually found *Mangrove Swamps*, which show a most wonderful adaptation for these extraordinary localities.

On sand and sand-hill (dunes) near the coast there is in many places a special association consisting of very scattered plants, which are creeping, with long, deeply rooting stolons. It is wonderful how the members of different orders growing here under the same surrounding circumstances assume the same appearance. We find here grasses (*Spinifex*, *Zoysia*, etc), nut grasses, pea-flowering plants (*Papilionaceae*) and especially one convolvulaceous plant—*Ipomoea Pes Caprae* or the so-called Goat's-foot. The last-mentioned plant is very common in the same plant association in different tropics, and provides a good name for the whole association (*Pes-caprae-association*). Later on plenty of other herbs and especially shrubs appear on these sandy localities near the sea-coast. This shrubby association is splendidly developed in the Southern portion of Queensland, from Frazer's Island to the islands of Moreton Bay, also on some of the Reef Islands. We find here a great number of different shrubs, most of them of the same mode of growth, but belonging to different families. At the time when most of its component members are in flower (August and September), this association is the most wonderful in the whole State, as no other offers such a quantity of showy flowers as this. The different *Epacridaceæ*, *Myrtaceae*, *Papilionaceae*, etc., are at this season covered with thousands of blossoms.

In fresh-water swamps, especially near the sea, there is usually found a most remarkable association, which deserves the name of *Tea Tree Swamps*, as the prevailing trees and shrubs are usually called "Tea-tree." There are many different *Myrtaceae*, often with she-oaks (*Casuarina*),

which make on some localities a special sub-type of this formation (*She oak swamps*). We find the adaptation of this association again very interesting. The plants growing here must at one period of the year resist the effects of floods, at another season again they must bear dry weather. Neither the vine-scrub nor the open forest is able to grow under these circumstances. In the first stage the tea-tree swamps have hardly any undergrowth, the water at the end of the wet season being full of splendid water lilies (*Nymphaea gigantea* and others), which seem to disappear in the dry season. No other association gives us such splendid opportunity to study the changes in the vegetation as this, for the conditions change often in a comparatively short time. We can observe in many localities how the tea-tree swamps take, by and by, the character of forests and at last become permanently so. On the other hand I saw in the district of Cairns different transitions between tea-tree swamps and vine-scrubs. Tea-tree swamps have in the North of Queensland often beside their own plants elements both of the forest and scrub floras. With the change of conditions one of them becomes more plentiful. In Southern Queensland we see regularly slow transitions into forests; in Northern Queensland, however, where the conditions are more favourable for the scrub plants, sometimes into vine-scrubs.

A special association is the *flora of salt and fresh water*. On marshy, muddy ground near the sea and often in the neighbourhood of mangrove swamps we find sometimes a special association of salsolaceous plants. Near the inlet opposite to Cairns this association is very well developed.

On many small islands along the Eastern coast of Queensland we observe a strange phenomenon, as some parts of these islands are barren or covered only with grass or other low vegetation, while some other parts are timbered with open forest or sometimes with vine-scrubs. The reason for this strange and very irregular distribution of forest cannot be found in the different character of soil, as it is to be seen on perfectly identical strata and apparently under quite congruent circumstances. I think, however, that the prevailing winds give us the correct explanation for this phenomenon, as we may observe that the exposed parts of islands, where the air is drier and the decomposed

parts of rocks easily carried away by means of wind, are barren (or nearly so), the protected parts are timbered. This everybody can observe in cases where the direction of the prevailing winds has not been disturbed. In many cases, however, there are groups of islands and then the direction of wind changes according to their position, and it seems at first sight impossible to find a plausible explanation for the phenomenon mentioned above. I hope in a special paper to deal in detail with this interesting question.

The other type of forest is the very well known *open forest*, with close undergrowth of grasses and scattered trees, mostly from the genus *Eucalyptus*, known under different names as gums, box, stringy bark, ironbark, Moreton Bay ash, coolibah, bloodwood, etc., etc. The other trees growing in the open forest are not only botanically but also in their ecology very different from scrub trees, and these two forest associations have no similiarity at all. Forest grows under conditions insufficient for vine-scrub, either from the character of the soil or the small rainfall. Most interesting is the contact between the open forests and vine-scrubs in the Northern and Central portion of Queensland. *The line of demarcation between them is most distinct*, a phenomenon which is unique in the whole world. I had opportunities to examine these relations in many places and found that the reasons for this most decided demarcation are different on different localities.

Sometimes it is simply the question of water. Along the creeks (where there is usually better humus) there are vine-scrubs; further on there is open forest country. In some localities a forest pocket occupies a circular slightly elevated ground between rich alluvial soil timbered with vine-scrub. In other places, however, the reasons are insufficient to explain this sharp line. Besides the conditions stated, I found these factors of great importance.

1. The forest flora consists of true Australian types; the scrub flora for the greatest part of Malayan and Papuan types. The historic evolution of these elements has been *quite diverse*, and we find always that they never come into a friendly contact. They are of quite different character, and on localities where the conditions are not decidedly

in the favour of one of them, there results a *strong struggle* between them. They do not enter into a special association with the representatives of both types (as it is usual in other countries with forest associations), but each one tries to get the upper hand. Therefore we cannot expect a mixture of types and slow transitions from one forest type into the other.

2. But all these reasons would not be sufficient, if one factor were not here, and that is *the regular bush fire*, which kills all the scrub plants springing up on the border of the forest.

3. Last we must deal with so-called "*forest pockets*," in which the phenomenon mentioned above attains its highest evolution. In some few cases there is no difficulty in explaining these forest pockets. On the slopes of Grant Hill, near Cape Grafton, in the North of Queensland, is for instance a system of creeks running mostly through open forest, but accompanied by a dense narrow belt of vine-scrub. In some places, however, the creeks are close together, and besides they often change their course, as is usual on the granite hills and mountains in this country. The result of it is that a bigger area is sufficiently watered, and this enables the vine-scrub to occupy the whole ground. But in one case the bordering creek was too distant from the next current. In the middle of this part, which was evidently drier, was a forest pocket of nearly circular shape enclosed on all sides by dense vine-scrub.

But there are in the Atherton scrubs forest pockets of a circular shape, some of them not broader than one mile; the line of demarcation is here most distinct. It is very hard to explain this most extraordinary contact between forest and scrub. My opinion is that there are again two different reasons :—

a. Sometimes the stratum of basalt is in some places very thin, and the soil consequently poor, insufficient for a vine-scrub.

b. In other cases I regard the forest pockets as a remainder of a former bigger open forest, which has been obliged to give way to the scrub. But on very small areas, where the scrub land had not so great possibilities, there remained forest pockets, which, I think, would disappear

if the bush fires did not protect them against the invasion of scrub.

There are again very different and distinct types of open forest. In the North must be specially mentioned the Eucalyptus forest with close undergrowth of high grass (as the typical form of the open forest), further with plenty of grass trees (*Zanthorrhoea*) or Cycads (or sometimes both together), or with plenty of she-oaks, etc.

Most interesting is the open forest country in the far West, for instance near Cloncurry. We find along the Northern Railway on the Rolling Downs formation everywhere open grassy plains, but with the beginning of the Silurian strata they disappear at once and give way to a special type of open forest with plenty of so-called "Spinifex" (*Triodia*) in undergrowth. This country is usuallly called "desert country," but it is a true open forest. It is an interesting fact that very far West the open forest has so wide an area; its character is, of course, according to the soil and climate, very poor.

A special type of open forest is to be found on the sandy soil in some places near the Main Dividing Range in Northern and Central Queensland. The undergrowth is not close, and consists, instead of grass, of different shrubs. This type recalls another forest association slightly developed in Queensland (for instance in some places in the rough country between Stanthorpe and Wallangarra), but extending over large areas in New South Wales, where the whole country from Newcastle and Sydney to the Blue Mountains (except the gullies) are the best known localities for this forest with plenty of shrubs and grass in undergrowth.

In some parts of North Queensland there is on the ranges near the coast another type of open forest, consisting mostly of she-oaks (*Casuarina*) with tall grass trees between, the grass being less dense than in the true gum forest.

A quite different type of forest—and perhaps not a true forest—is seen in the different wattle-scrubs, which are spread over areas between the open forest and the Rolling Downs formation, larger than those of any other plant formation in South West Queensland. A wattle called brigalow (*Acacia harpophylla*) makes large irregular scrubs. In the neighbourhood of Clermont, and in many places

between Clermont and Rockhampton, are in patches in the open forest and on many ridges *rosewood scrubs.* Further westwards, everywhere in the Central and Northern districts, we find mostly *boree* and *gidya scrub*; both are species of *Acacia.* Boree prefers good, nutritious soil, and is often found in smaller or larger patches on Rolling Downs. Gidya grows more on ranges and on poor, often rocky soil. Most of the Table Mountains are covered with gidya scrub, but on their top we find regularly "Spinifex" (*Triodia*) and a set of xerophilous shrubs. All these trees, although of small size, give a splendid hardwood, one of the best I ever saw. I am perfectly satisfied that they will be used to a great extent in the future. As an interesting fact I may mention that this wattle scrub has spread in historical time over open grassy country, as I observed it in Central Queensland, and Inspector J. Shirley informed me that he had noted it between Roma and Taroom in Southern Queensland.

The trees (boree and gidya) grow very slowly. Many of the trees killed in the big drought of 1902, which I met on the Rolling Downs, must have been surely 100 years old. I regard it as a good testimony that at least during the past century there was in Queensland no drought of such frightful extent.

On the Main Dividing Range, between the Northern and Central Railway there is everywhere a quite different forest association, not mentioned until now. The prevalent tree is an *Acacia* called *lancewood.* It grows very high, has long straight branches and a flat top. The stems are not very thick and the wood splits easily, but the trees are very tall, so that these lancewood scrubs are of quite different character from all other wattle scrubs, which never grow in tall closed forests. Besides these, there are plenty of shrubs in the undergrowth, so that this forest association is closely allied to the forest of New South Wales mentioned above.

These lancewood scrubs are on the rough Desert Sandstone country, where the conditions are, of course, different from those of the flat country. In some places between Jericho and Alpha, I found forest pockets enclosed by the the lancewood scrub with a most decided line of demarcation. This phenomenon, unobserved until now, is of the same striking nature as the pockets mentioned above. Here is, however, a different reason; it is the question of soil. The

sandstones are broken and the lower strata are coming on the surface. Sometimes it is in the form of a gully, and then the greater moisture is in favour of forest. It would be superfluous to mention that in these forest pockets are regular bush fires, while in the lancewood scrubs there are none.

From Jericho eastwards we find again a different type of wattle scrub, very closed and dense, with prevalent *Acacia* and *Eucalyptus*. Bottle trees (*Sterculia rupestris*) are very abundant, but are not clustered together.

Great areas in the Central and Western districts of Queensland are occupied by the Rolling Downs formation, and covered with *open grassy plains*; in the Northern part with prevalent Mitchell grass (*Astrebla pectinata* and others) and Flinders grass (*Anthistiria membranacea*); in the Southern more with blue grass (*Andropagon sericeus*).

These open plains possess an association, which has no parallel in any other part of the world. It is usually not a dense vegetation. The predominant grass is the deeply rooting, perennial Mitchell grass, really a marvellous fodder. Between its tufts there grow after the rain plenty of annual plants, of which the Flinders and Button grasses are the most valuable. In the Eastern parts we often find patches of scrub, especially boree. But further Westwards there are miles and miles of open plains, and only near the watercourses are scattered gums (especially the so-called coolibah) and tea trees (*Melaleuca* sp.). Some few shrubs are growing in small gullies; very common is a thorny *Acacia* called "Mimosa," and regarded as a sign of water underneath. Fuchsia bush—a species of *Eremophila*—is scattered here and there. Of the taller treees there are found some few "emu-apples," whitewood, *Myoporum*, etc.

Rolling Downs give the best possible grazing land. If in the future the system of conserving hay may become general, there will be no such catastrophes as after the big drought. But I do not think that there is a possibility for *close* agricultural settlement. This part is a splendid grazing country, and gives besides opportunity for growing fruit and some vegetation to a smaller extent along the bigger watercourses. It is a pity that this is until now in hands of Chinese, who make good profit, but do not spend their money in Queensland. It would be a great advantage

to promote the immigration of skilful people from Europe, who could stand the competition with the Chinese, as the English people are usually not fond of this branch of agriculture.

As there is not much time left, I will mention only some of the other plant associations of Queensland :—

1. On the very top of Bellenden Ker there is a most extraordinary form of low *mountain scrub*, consisting of different shrubs with extermely hard branches. It is nearly impossible to penetrate through this thicket, which is in many respects of high importance, as there are found several plants (for instance *Agapetes Meiniana*, *Rhododendron Lochae*), which have their affinities in the Malayan and Papuan mountains. This association covers only the narrow top of the mountains and the slopes some 80 feet below. Except this, the whole mountain is covered with dense tropical vine-scrub, of course of different types at different heights. The soil is everywhere on the eastern side granitic and poor. The ascent of the central highest peak is certainly not so difficult as one would suppose after reading the travels of *Mr. Arch. Meston*. The eastern side of the mountain is not such good timber country as the scrubs on the basaltic plateau. There are comparatively few trees, which are sufficiently numerous and are of a high mercantile value. Meston's Mangostoen (*Garcinia Mestoni*), botanically an extremely interesting type of the flora of Bellenden Ker, described and discovered by *F. M. Bailey*, is very plentiful in the eastern slopes in an elevation between 2,500-4,000 feet. But the value of the fruit was exaggerated by Mr. Meston, and I regard all experiments with this tree as useless. First, it will not do well in the low land; and second, its fruit is of no special taste; naturally it cannot be compared with the true mangosteen (*Garcinia Mangostana*).

2. *Shrubby plant association*, consisting of plenty of low shrubs with little grass and few small trees, is often found on loose sand in the inland country. It is a Xerophilous association.

3. On the islands of Moreton Bay, and also near Sunnybank, in the vicinity of Brisbane (and surely in several other localities), is to be found an extremely interesting

association, not identified until now. It is a true turf in different stages and with a very rich flora, consisting chiefly of *Restiaceae*, *Cyperaceae*, etc., with some *Epacridaceae*, *Dilleniaceae*, small *Myrtaceae*, *Burmannia disticha*, *Utricularia*, *Drosera*, etc. Turf-moss (*Sphagnum*) is usually not present, but sometimes it is present in large quantities (f.i., Stradbroke Island).

4. *Limestone flora.* I had opportunity to examine the limestone country near Chillagoe, where on the limestone bluffs is a type of flora quite different from all associations mentioned above. There are many plants peculiar to these parts. The flora consists of many shrubs and small trees, and has so many peculiarities that it would require a special lecture to give only the rough outlines of its general character. I was glad to make the first botanical investigations of great extent in this very interesting country.

5. There is a special flora on the rocks along the coast of Queensland, but it is not much developed. In the Glasshouses this association has some interesting members (*Micraira subulifolia*, *Eriostemon myoporoides*, *Grevillea leiophylla*, *Dodonaea vestita*, *Melaleuca Luehmanni*, besides the commoner rock plants, as *Cheilanthes*, *Polypodium rigidulum*, *Peperomia*, *Plectranthus*, etc.)

In the North there are hardly more than 20 characteristic species accompanying the rocks.

Let me now say some few words about the evolution of the flora of Queensland. We find in Australia three different elements represented in a very unequal degree in the flora of the different States. There is, first, the true *Australian* element; second, the so-called *Antarctic* element (named so by *Hooker*); and, last, the *Malayan* (including the Papuan) element. The second element, which is of such great importance for the flora of New Zealand and the mountains in the south-east corner of Australia, is (with a few exceptions, as for instance, *Dracophyllum Sayeri* on the top of Bellenden Ker), not represented in Queensland. Both the other elements are in Queensland well represented, and the Malayan element is in no other State so rich as here. The Australian element, which attains its highest evolution in Western Australia, must be regarded as the true old Australian flora; in Queensland it is spread over the drier districts and is especially rich in Southern Queens-

land (islands of Moreton Bay). The Malayan element makes the base for the flora of the vine-scrubs. The wet tropical part of Queensland has altogether a true Malayan-Papuan flora, which shows that there was formerly a land or island connection and an easy way for propagation of this equatorial tropical flora southwards. But it would not be correct to regard Queensland's tropical flora only as a new comer and a recent branch of the regions mentioned above. All that we know seems to testify that :—

1. The tropical "Malayan" flora of Queensland is only a small remainder of a flora spread formerly over large areas, which are now mostly sunken into the sea. Accordingly,

2. The flora does not consist only of the original Malayan types. These made only a base, but it has been transformed in the great number of genera and species, which are known only from the Australian Tropics (endemic in Australia). It seems that the separation took place at a very early epoch, so that the ancestors of the present tropical flora in Australia developed themselves quite independent of the Malayan flora, and originated a large number of new forms.

Now we understand the difference between the Malayan and the Australian elements, and we can imagine the struggle which certainly took place after the best and largest localities for the tropical flora disappeared under the sea level. In the Southern part of Queensland there are some differences, as the true Australian type is represented in a few special forms in the vine scrub flora. I may mention for instance the gigantic water gums (*Eucalyptus botryoides*) (besides some other gums, as *Euc. resinifera*) in the vine-scrubs on the basaltic mountains in Southern Queensland. Here the contrast is not so great, and we find sometimes different transitions, especially in the brushes, which have in some places quite a mixed character. But we must not forget that just here most of the Malayan types, which require the most favourable conditions, are not so plentiful. Antarctic elements are, of course, missing, the most curious ***Fagus Moorei*** in the Macpherson Range being an interesting exception.

My studies in different parts of Queensland brought me to the conclusion that the open forests in all parts of

Queensland are not a natural association, but a *secondary* one, changed through the influence of their aboriginal inhabitants, mostly by means of bushfires. It seems rather strange to regard such immense areas in a virgin country covered with open forest as a secondary association, but I hope to bring in another place sufficient proof for it, and I will try to give a reconstruction of their original form, which differs substantially from their present character.

Last, but not least, I will make a few remarks regarding the agricultural prospects for the future, which are closely connected with the botany of the State. Everybody who is familiar with the different plant associations of a country must know thoroughly all the conditions of soil, climate, etc., for the distribution of plants in special associations shows it in a most striking manner. Therefore, it is not useless to go deeper into all these questions and to try to understand the conditions of the plant-life as much as possible. I think everybody who took a keen interest in the connection between the plant-life and its surrounding circumstances, could easily recognize from the character of the vegetation the nature of the country.

No doubt, in Queensland is opened a field for tropical agriculture as well as for cultivation of subtropical plants, and some from temperate regions. It is, of course, necessary to choose the right plant.

I think, there would be a possibility of cultivating a great variety of tropical plants in North Queensland, but just these, which would be of special value, are not fitted for it, as the rates for white labour are so high, that it would not pay to cultivate such plants as coffee, tea, rubber, etc., which must be looked after the whole year round. Sugarcane will surely remain the most important plant for the future. In smaller quantities it would be, of course, possible to cultivate plenty of tropical plants, but that is not of great importance for the rich coastal scrub districts. Only a few of the true tropical plants do not grow here well, and these are plants which must have rain the whole year round. That is the case with the pale rubber (*Hevia Brasiliensis*), with the true mangosteen (*Garcinia Mangostana*), etc.

It seems to me much more important to cultivate a greater variety of plants in the central drier districts.

At least as far as Charters Towers, along the Northern Railway, and as far as Barcaldine around the Central Railway, it would be possible to cultivate sufficient fruit not only for the settlers' own use, but for a supply to the far West. There is a possibility for much more fruit and vegetable growing: there could be grown many plants hardly cultivated as yet. *Arochis hypogaea*, date palm, and plenty others would be worth trying.

It seems strange for a visitor to see how European fruits are cultivated in Queensland on localities where they cannot do well, but where it is easy to grow any amount of excellent tropical fruit. Once being in the tropics, it is best to adapt ourselves to them, to take tropical fruit, to adapt the houses to the tropical climate, etc. I was always wondering how little are estimated the yams, which can be grown to perfection, and which are surely more valuable than pumpkins.

Notwithstanding all this, marvellous progress can be observed in agriculture, and no doubt, with the increasing population, we may expect still more improvement.

And last I must express my thanks, not only to the authorities who helped me in a most effective and kind way to carry out my plans, but to everybody whom I had the pleasure to meet, and whose hospitality was often a great help in rather rough conditions of climate and country. I regard it, with my friend, Dr. Danes, as a pleasant duty to give our own people good information about the possibilities for immigrants in Queensland, and it would be only a pleasure to me if many of our agricultural people would come to your prosperous and hospitable State.

PHYSIOGRAPHY OF SOME LIMESTONE AREAS IN QUEENSLAND.

By DR. J. V. DANES
(Prague, Czech University).

Read before the Royal Society of Queensland, July 23, 1910.

During my stay in Queensland I had occasion to pay more or less hurried visits to three important limestone areas within the limits of the State, and I was able to make some observations about the present state and the development of some prominent and generally interesting features, which distinguish the pure limestone from most other common country rocks.

Pure limestone differs conspicuously from many other rocks by its comparatively easy solubility through the action of water charged with a slight quantity of carbonic acid. The water widens the joints and clefts in the rock structure, and tries to force a passage vertically into the depths. Where the vertical progress is impossible, the water proceeds more or less horizontally, or follows the inclination of the beds, and starts again in the vertical direction if possible, until it reaches the base of the previous rock or the upper level of the underground water. The disintegrating action of the water upon the neighbouring rock is slow in the beginning and purely chemical; but later on the cavities become so wide that the running water starts on the mechanical work, grinding the rocks with sand and gravel set into rotatory movement by vertical whirls, or scratching the surface with the same material, where the passage is more or less horizontal and unobstructed. Subterraneous passages, extended systems of caves, are results of that process, and their presence is the most characteristic feature of the limestone areas,

especially to an untrained eye. Almost all famous caves of the world occur in limestone.

But the existence of caves is not the only result of the subterraneous passage of the waters. The rocks below the surface diminish gradually in volume, and concentric depressions form. Many of such depressions are formed by a slow gradual process, but others are the result of violent, although only localised, processes, being caused by sudden collapse of the roof of some cave. The shapes of such sinkholes* explain generally the way in which they originated, and very often the deep, abrupt sinkholes form entrances to the subterraneous passages. On a limestone area containing caves and sinkholes the rain water falling upon the surface does not flow away in streams, but disappears underground. No regular graded valleys are formed. Running water flowing in creeks or rivers from areas of impervious rocks seldom succeed in eroding an open valley through a limestone area. It generally disappears in fissures or sinkholes, and continues its way in subterraneous passages, reappearing again on the surface where the limestone area ends, or flows often subterraneously to the sea.

Many of such subterraneous watercourses can be followed on the surface, deep sinkholes marking the direction of the caves, but many of them are completely lost to the human eye. It seems probable that in some limestone areas the cave systems are not yet fully developed, and that the waters after some progress in defined streams lose their individuality, and become a part of a general ground water basin, which fills all cavities and fissures to a certain level throughout some limestone areas. Such conditions seem to prevail in limestone areas, which are morphologically young, and which have not been long (geologically speaking) exposed to the disintegrating agencies.

During the further evolution, the defined underground watercourses become more and more general, and prevail completely in morphologically old areas.

The caves in their young stage show everywhere unmistakable proofs of violent mechanical work performed

* For sinkholes the Servian term "doline" is most extensively used in scientific literature

by water, by help of sand, gravel and rock debris, and are full of potholes of very diversified size and aspect. In old caves, the traces of the mechanical action are generally obliterated; the old channels are filled by loam, sand and secondary limestone, the walls covered by secondary limestone, and numerous, often beautiful and picturesque stalactites and stalagmites give the most attractive appearance to old caves. Gradually the roofs give way to pressure, and often in old limestone areas there occur long, narrow, precipitous gorges, which were caves before the collapse of upper layers of rocks. Blind valleys are the result of such a process, and also broad level basins* occur in some extensive limestone areas with rivers and creeks, which on one side leave the subterraneous passage, and on the other side disappear once more under the continuous barrier of rocky ridges.

Many limestone mountains represent rocky deserts, whose passage is very difficult, there being no definite valleys, which generally form the most important ways of communication in rugged mountainous countries.

Where the limestone rocks are devoid of vegetation, the chemical and mechanical action of the falling rainwaters affects the surface in a peculiar way.

The edges and corners of limestone blocks look as if worked by a fine chisel, and later develop deep correlated forms; extremely sharp and fine ridges fall abruptly into miniature valleys or basins, which generally end at a fissure or a cavity, where the water disappears into the underground depths.

This phenomenon is very well developed, especially on many barren limestone ridges and plateaus in the Alps, and is known under the name of "Karren" to the Germans, and "Lapiaz" to the southern Frenchmen.† All those forms of terrain, which form the peculiarity of the physiographical character of the limestones, are known as the "Karst phaenomena," "Karst" or "Kras" is a South Slavish word designating a barren, rocky country, and was originally applied to the vast limestone

*Such basins are called "poljes," and occur along the Adriatic coast, in the French Jura, and in Jamaica. The greatest "Livanjskopolji" in Western Bosnia covers about 180 square miles.

† In the Adriatic Karst.

plateaux and mountain ranges along the north and north-western margin of the Adriatic Sea in the southern countries of Austria-Hungary and the Balkan Peninsula. It became a generally acknowledged scientific term for the forms of terrain of soluble rocks.

The caves, although they are one of the most important "Karst phaenomena," are known also from other formations, especially from basaltic rocks, from sandstones, and conglomerates with soluble concrete, but the true development of "Karst" is characteristic only of the limestone among the very important country rocks. Rocksalt, gypsum and glacier ice develop also the characteristic features of the "Karst," but their significance is minimal, as they occur rarely in great continuous masses.

With the hope that the somewhat extensive explanation of the characteristic features of limestone physiography will give you an idea sufficient to understand my further remarks, I shall proceed to a description of the chief features of the limestone areas I saw in Queensland.

A long and narrow belt of limestone ridges extends in the surroundings of Chillagoe from Almaden in a north-westerly direction, about 20 miles beyond Mungana. The geological character of the country has been described several times by prominent geologists as Dr. Jack, Prof. Skertchly, Mr. Dunstan, and also some descriptions of the caves have been given. The limestones were deposited in the Silurian period, and their position has been violently disturbed through tectonic processes.

The Chillagoe caves are famous as one of the picturesque attractions of North Queensland, and they deserve their fame, although the general extent and size of the principal caves cannot compete with many others of world's fame. The limestone ridges are low, only 100 to 150ft. high above the valley level. The floors of the principal caves are generally on a level corresponding with the surrounding country, and so the elevation of the roof seldom exceeds 60ft. from the floor. The stalactites and stalagmites are not so numerous as in other caves with a more humid climate, but the secondary deposits cover the walls and the floor so thickly that traces of erosion are

almost completely obliterated. The great development of secondary deposits is an unmistakable proof of the old age of the caverns; another proof is, that many roofs have collapsed, and open sinkholes with almost perpendicular walls are met with in rambles through the subterranean labyrinth. Waters which eroded those caves left them some time ago, and thick layers of "cave-earth" cover the floor of horizontal passages. The outer appearance of the limestone bluffs perforated by caverns in the interior is very rugged, and the bluffs are very inacessible.

The Karren phenomena is developed on most of them in very bold and sharp forms. A climb to the top of a bluff reveals a really stupendous labyrinth of sharp correlated rocks, deep perpendicular chasms, miniature caves and recesses, but further progress is very slow and tiresome, and the edges of the rocks, sharp as a knife, leave disagreeable traces on the dress and skin.

Most of the bluffs in the Chillagoe district are of such rugged appearance, with the exception of one group south-east from Chillagoe. A peculiarly shaped, smooth-faced limestone bluff, called generally "The Lion's Head," is known to everybody who has been in Chillagoe. The base of the bluff is full of potholes leading underground, and one narrow passage opens into the centre of the Lion's Head Bluff, ending with a deep sinkhole. All surrounding rocks are smooth on the surface, and differ very conspicuously from most of the others. There can be no doubt that the Lion's Head and its surroundings owe their shape to the vigorous action of running water in some remote period. The bed of the short ancient river was at a considerable elevation above the present creek beds in the environs. The base of the Lion's Head is about 100ft. about the present creeks. The Lion's Head Bluff is an unmistakable remnant of the old landscape, and I can recommend it to the attention of future investigators, who will be certainly able to say more about the former direction of the drainage at much higher level than the present, and the subsequent evolution of the landscape.

From Rockhampton, I visited the Olsen Caves, which occur in a limestone ridge about 16 miles in an almost northerly direction from Rockhampton. There are several ridges and bluffs to the east and south-east of Mount Etna,

a conspicuous conical landmark. The limestone is of Devonian age, as proved by corals determined by Mr. Rands. Mr. Rands gives in his report a very good description of the Olsen Caves, and also of a second group, the Johansen Caves, is another mass of limestone.

The Olsen Caves, which perforate in several passages the narrow limestone ridge, are in size and height very much like the Chillagoe caves. The rivers or creeks which once eroded them left them long ago, but the secondary lime deposits, and especially stalactites and stalagmites, are much less conspicuous than in the Chillagoe caves. The lack of this picturesque and ornamental element makes them less interesting for an ordinary tourist, but for a student of physiography, the work of the running and whirling waters is well preserved and very interesting. The small amount of secondary limestone, and also the better preservation of the caves, although the ridge is only of the same elevation as over the Chillagoe Caves, shows that they are in a younger stage of development. Innumerable bats have their refuge in these caves, and the deposit on the floor is a magnificent guano preserved by nature for the use of future agriculturists. The top of the ridge shows a most beautiful and diversified development of the "Karren phenomena," and is more accessible than the tops of the Chillagoe bluffs, the disintegration being not so far advanced, and the roofs of the caves solid.

Many other limestone areas are met among the paloeozoic rocks in the mountainous eastern parts of the State, and their morphological development will be of great help to a student of the geological changes in the latest periods, since limestone more than other rocks preserves the old landscape and reveals many details, which serve as unmistakable proofs of older stages of the drainage system.

In the farthest north-west of the State a high level plateau called Barkly Tableland extends and continues very far into the Northern Territory. The age of the limestones is yet unknown, but the depth of the continuous limestone strata is so enormous that it is quite possible that they consist of layers deposited in very different geological periods. Their extent is better known in the

Northern Territory by the explorations of Mr. Brown, the Government Geologist of Southern Australia.

That limestone area, so far as it is known, differs in many respects from the limestone outcrops in the very disturbed mountain ranges along the eastern coast. The beds are in almost undisturbed horizontal positions, except in some places along the eastern edge, as Mr. Ball kindly informed me. They fill out a vast basin of unknown depth. The bores, of which the deepest is on Alexandra Downs Station, 1,700ft. deep, did not reach the base of the limestone formation. The surface of the Barkly Tableland, and also of the connected plateaux in the Northern Territory, represent a very good grazing country wherever the limestones form the surface, but gravelly ridges consisting of jasperised boulders and pebbles are in places very extended, and covered by poor open forest and spinifex grass. The water on the surface is scarce, and only the Georgina River contains some permanent water holes, called lakes. Two of them were the refuge of Landsborough's exploring party. One of them, Lake Francis, supplies Camooweal, the thriving economical centre of the Tableland; near the other, "Lake Morry," the homestead of Rocklands Cattle Station is situated.

The lack of a superficial water supply would be a great drawback to the future development of the good grazing country, but the limestone basin contains in the underground depths a magnificent supply of water, which can be reached by bores and pumped in unlimited quantities. The eastern part of the Tableland is formed by an impure limestone, where the underground water supply is very limited and not sufficient for practical purposes, but that area is luckily only an insignificant part of the Tableland, which, so far as the limestone extends continuously, can be sure of an unlimited water supply in bores reaching not below 4-500 feet. The extent of that basin in Queensland is not yet known, but reaches more than a hundred miles further south than suggested until the present. The value of that water supply will be of immense significance for the future development of the farthest West of Queensland and of more extended areas within the Northern Territory. One good quality of it is that pumping is necessary, and so the wasting of superfluous water as in the case of artesian bores

can never become dangerous to the very existence of the water supply for the future generations. Now almost all of the stations on the Tableland and in the South-eastern part of the Northern Territory use that subterranean water, and in the future a practically unlimited number of bores will make the extensive use of that Territory for stock one of the most important resources of the interior. I shall be very glad indeed if the present remarks reach the State Governments concerned, and if a thorough geological survey from both sides prove to what extent my suggestions are of practical value for the development of that, until the present, very little known and neglected country.

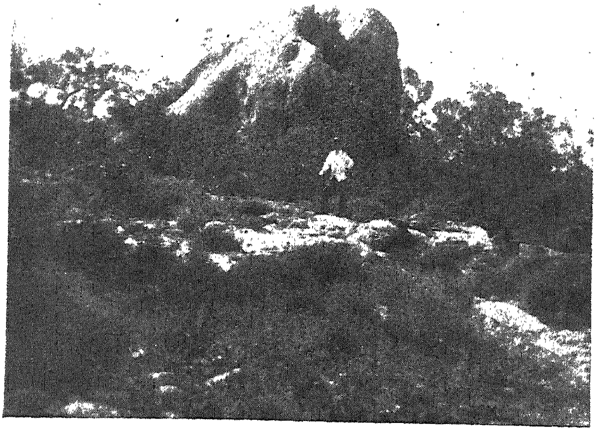
The subterranean basin in the limestone formation gives a permanent water supply to many magnificent rivers and creeks, whose surrounding areas can be the basis of closer settlement in the future. On the Queensland side, the Gregory River derives her splendid stream from numerous springs in the limestone, the lime suspended in the water is deposited in some places in the form of travertin and calcareous conglomerate, forming natural dams across the river bed, which the stream leaps in a number of picturesque cataracts and rapids. In the Northern Territory the McArthur, the Roper, the Victoria, the Daly and many other streams get their permanent, splendid quantity of water out of the subterranean limestone basin.

The surface of the plateau is very level and the strata almost undisturbed, and there are extensive patches of country covered by a sandstone formation corresponding very probably with the so-called desert sandstone formation in age and aspect.*

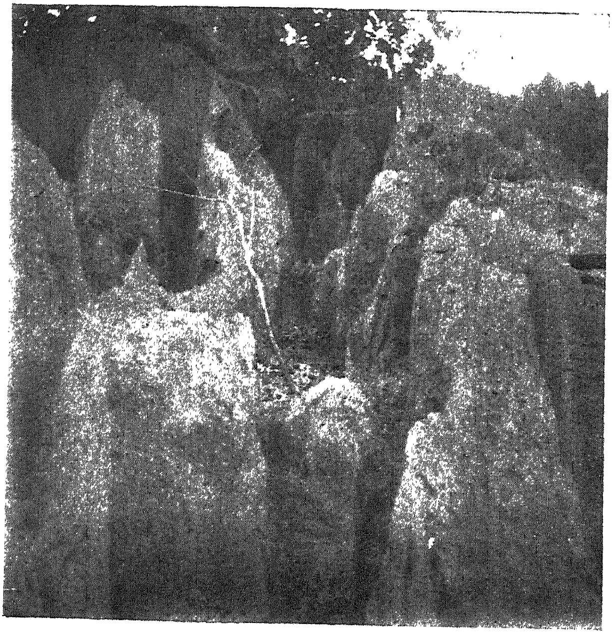
The caves are not very numerous, but they are extremely interesting from the very young stage of development they represent. They seem mostly to be due to fissures crossing the country in an almost north-south direction, and several groups of caves and sinkholes are known in the environs of Camooweal. I visited most of them. The best known are the Nowranie Caves, about 10 miles South-South-East from Camooweal, accessible over a precipice and extending in two levels for some hundred

* On the Queensland side a small desert sandstone plateau forms the divide about 30 miles east from Camooweal, near Wooroona Creek.

yards. The development of secondary limestone is insignificant, and stalactites and stalagmites very scarce. The water level is about 240 feet below the surface. Another very intererting group of caves and sinkholes is one about 4½ miles north from the Rocklands Station. I named that group after Mr. A. H. Glissan, the manager of the Rocklands Station, who has a very deep interest in the scientific and economical development of the Tableland, and has gathered most valuable information about the character of the subterranean water basin. Further to the West the Happy Creek sends a great part of its waters to the subterranean basin through a sinkhole. The "Karren phaenomen" is only in its beginning—everywhere on the outcropping rocks.



LION'S HEAD, CHILLAGOE.



LAPIAR (KARREN PHAENOMEN) OCEAN CAVES RIDGE.

WATERHOLE IN THE WOOROONA CREEK, EAST FROM CAMOOWEAL (IMPURE LIMESTONE).

A. H. GLISSAN'S GROUP OF SINK-HOLES AND CAVES. BARKLY TABLELAND.

"ENDEAVOUR SERIES NO. 1."

ON SOME NEW FISHES FROM THE QUEENSLAND COAST.

By J. DOUGLAS OGILBY.

Read before the Royal Society of Queensland, November 20th, 1910.

Since the delivery of the above Paper and the issue of the Author's Copies, the Council of the Royal Society has been informed by the Commonwealth Authorities that the Australian Museum in Sydney had, before the expedition sailed, been officially entrusted with the scientific description of all the Fishes secured, a fact of which the Council was not aware until March, 1911. As most of the fishes described in the Paper have been forwarded to the Australian Museum, the Council has decided to withhold the Paper from publication in the Proceedings.

NOTES ON THE ROTIFERS OR WHEEL ANIMACULÆ OF BRISBANE.

By W. R. COLLEDGE.

Read before the Royal Society of Queensland, May, 28, 1910.

According to Gosse, "a rotifer is a microscopic animal found in fresh or salt water, which swims by means of cilia on its head, possessing jaws, stomach, and digestive glands, muscles, a well-developed vascular system, and nerve ganglions with fibres passing to the organ of sense." 825 species are known, 300 are found in America, double that number in England; other countries contribute their quota; even Shackleton caught some in his latest expedition to the Southern Pole. Canada is the only place from which we have no record, probably because no student has searched its waters.

A little work was done in Queensland in 1887 and 1889 by a Naval Officer, Surgeon Gunson Thorpe. Two papers, with a list of 23 species are found contributed by him to the Transactions of the Royal Society of Queensland about that period. Seeing that this branch of science would repay a little study, I have devoted the most of my spare time for the last two or three years, and have been able to increase the number of these interesting creatures known in Queensland to 102 species.

Those mentioned in Surgeon Thorpe's papers are marked by an asterisk, the rest have all been found in the neighbourhood of Brisbane.

ORDER I. BDELLOIDA.—Creeping like a leech usually, but able to swim freely when they choose to do so.

FAMILY 1.— Philodina citrina.*
Rotifer neptunius.*
Rotifer vulgaris.*

ORDER IV. RHIZOTA, or rooted ones. These are fixed in one place and rarely move from it during life.

FAMILY IV.— Floscularia coronetta.*
,, longicaudata.
,, ornata.*
,, campanulata.

FAMILY VI. — Melicerta conifera.*
,, ringens.*
Limnias ceratophylli.*
,, annulatus.*
Æcystes brachycera.
,, crystallina.
Conochilus dossuaris.
,, unicornis.
,, volvox.
Stephanoceris eichornii.

ORDER V. PLOIMA, or free swimmers.

SUB-ORDER 1.—Illoricate.

FAMILY 7. — Microcodidus chloena.
FAMILY 8. — Asplanchna amphora, male.
,, ,, female.
,, brightwellii.
Sacculus viridus.
FAMILY 9. — Synchæta stylata.
,, ovalis.
,, tremula.
FAMILY 10. —Triarthra longiseta.
Polyarthra platyptera.*
FAMILY 11. —Cyrtonia tuba.
Notops brachionis.
FAMILY 12. —Copias copias.
,, cerberis.
,, pachyurus.
Coelopus brachyurus.
Diglena grandis.
Eosphora aurita.
,, digitata.

FAMILY 12.—Furcularia æquales.
,, longiseta.
,, melandicus.
,, micropus.
Notammada aurita.
,, clavulata.
Proales sordida.
Taphrocampa annulosa.
Triopthalmus longiseta.

SUB-ORDER 2.—Loricata.

FAMILY 13.—Mastigocerca bicornis.
,, bicristata.
,, birostris.
,, carinata.
,, elongata.
Rattulus tigris.
,, mucosus.
Calopus porcellus.

FAMILY 14.—Dinocharis collinsii.
,, pocillum.
,, tetractis.
Scaridium eudodactylotum.
,, longicaudatum.*

FAMILY 15.—Salpina brevispina.
,, eustala.*
,, macracantha.
Diaschiza pæta.
,, semiaperta.
Diplax trigona.
Diplois davesii.*

FAMILY 16.—Euchlanis dilatata.
,, oropha.
,, triquetra.*

FAMILY 17.—Cathypna luna.*
,, leontina.
Monostyla bulla.
,, cornuta.
,, lunaris.*
,, quadridentata.

FAMILY 18.—Colurus amblytelus.*
,, dactylotus.
,, deflexus.
Metopidia acuminata.
,, lepadella.
,, oxysternum.
,, solidus.
,, triptera.
Cochlearis turbo.

FAMILY 19.—Pterodina patina.*

FAMILY 20.—Brachionis angularis.
,, bakerii.*
,, falcatus.
,, militaris.*
,, palæ.
,, ,, var. amphiceros.
,, rubens.
,, urceolus.
Noteus quadricornis.

FAMILY 21.—Anurea aculeata.*
,, ,, var., no ventral spines.
,, cochlearis.

FAMILY 22.—Pleosoma lenticulares.

FAMILY 23.—Gastropus minor.
,, stylifer.

FAMILY 24.—Anapus ovalis.

ORDER VI. SCIRTOPODA.—Skipping by means of jointed appendages.

FAMILY 25.—Pedalion mirum.*

This peculiar species was found at Dunk Island by Surgeon Gunson Thorpe, but I have found them in the city and suburbs occasionally.

Another species so peculiar in structure, that its position in the group is uncertain, is *Trochosphæra æquatorialis*. First found in the Philippine rice fields in 1859 by Professor Semper. It was next observed in Brisbane after the lapse

of thirty years by Surgeon Gunson Thorpe, who also discovered the male. It does not appear to have been noticed anywhere but in these two localities, and contrary to the usual wide distribution of rotifers, I have only caught them in two pools for a very limited time in the year. At the request of F. Rousselet—the great authority on these microscopic fauna—I forwarded a batch, and some of these were shown, for the first time to a London audience, and specimens supplied to the museums of the Quecket Club and the Royal Society.

ADDITIONS TO THE MARINE MOLLUSCA OF QUEENSLAND.

By JOHN SHIRLEY, B.Sc.

(Senior Inspector of Schools).

Read before the Royal Society of Queensland, 24th *September*, 1910.

At the meeting of the Australasian Association, held in Brisbane in January, 1909, the first list of the known Marine Mollusca of Queensland was published by Mr. Charles Hedley, Assistant Curator, Australian Museum, Sydney. This list forms part of the Presidential Address to Section D., Biology, comprised in pp. 343-371, of Volume xii., of the Proceedings of the Association. Pages 809-810 of the same volume contain a supplement to the main list. In all, some 1900 species are catalogued.

The following additions are drawn from a review of the cabinets of my son, Mr. Ray Shirley, who has been collecting for the past six years, and whom I have helped in every possible way. Owing to the greatly increased interest in natural history, many teachers of schools in the coastal towns have made collections of marine shells, and from these I have received many parcels for naming. This has given me an opportunity to study the mollusca from a very wide stretch of coast. I take this opportunity to thank Mr. F. Barrett, of Cairns; Mr. John Fewtrell, formerly of Townsville West, now District Inspector of Schools; Mr. Ivie Murchie and Mr. Long, of Normanton; Mr. E. Saunders, of Bowen; Mr. C. Kemp, formerly of Gladstone; Mr. Joseph Hirst, formerly of Bulwer, Moreton Island; Mr. W. Noon, Yeppoon; and Mr. James Bruce, of Murray Island, Torres Straits, whose collections have enabled me to add many species to the Queensland list.

I wish also to put on record the assistance I have had from my friend, Mr. Charles Hedley, who has named many parcels of shells sent down to him, and also from Mr. E. A. Smith, of the British Museum; Mr. C. J. Wild, of the Brisbane Museum: Messrs. C. Gabriel and J. H. Gatliff, of Melbourne; and Mr. A. Simson, of Launceston, Tasmania.

PELECYPODA.

Leda lata *Hinds*, Bundaberg.
Arca bicors *Jonas*, Moreton Bay.
,, Carpenteri *Dunker*, Moreton Bay.
,, Helblingi *Chemnitz*, Yeppoon.
,, lima *Reeve*, Gladstone.
,, pusilla *Sowerby*, Caloundra.
Byssarca zebra *Sowerby*, Townsville.
Glycimeris australis *Q. and G.*
,, ,, v. Greyana *Dunker*, Moreton Bay.
,, holoserica *Reeve*, Caloundra.
,, striatularis *Lamark*, Bundaberg.
Pinna angustata *Lamark*, Torres Straits.
Perna ephippium *Linnæus*, Torres Straits.
,, fimbriatum *Reeve*, Torres Straits.
Pteria marmorata *Reeve*, Yeppoon.
Meleagrina vulgaris *Schumacher*, Moreton Bay.
Ostrea circumsuta *Gould*, Moreton Bay.
,, glomerata *Gould*, Moreton Bay.
,, mordax *Gould*, Bundaberg.
,, ,, v. cornucopioides *Lamark*.
Pecten gloriosus *Reeve*, Yeppoon.
,, leopardus *Reeve*, Yeppoon.
,, medius *Lamark*, Normanton, Yeppoon.
Amusiuim japonicum *Lamark*, Moreton Bay.
Spondylus coccineus *Lamark*, Moreton Bay.
,, imperialis *Chemnitz*, Cardwell, Yeppoon.
,, tenellus *Reeve*, Caloundra.
Limopsis multistriata *Sowerby*, Moreton Bay.
Anomia achæus *Gray*, Thursday Island.
Modiola elongata *Swainson*, Yeppoon.
,, Fortunei *Dunker*, Caloundra.
,, vagina *Lamark*, South Passage.
Chamostræa albida *Lamark*, Bundaberg.

Myodora ovata *Reeve*, Caloundra.
„ striata *Deshayes*, Caloundra.
Crassatellites Cumingiana *A. Adams*, Caloundra.
Batissa violacea *Lamark*, Cairns.
Austriella sordida *Tenison Woods*, Bowen.
Codakia punctata *L.*, Capricorn Islands.
Cryptodon globosum *Förskal*, Tweed Heads.
Corbis Sowerbyi *Reeve*, Torres Straits.
Cardium cardissa *Linnæus*, Torres Straits.
„ latum *Born*, Moreton Bay.
„ munda *Reeve*, Bundaberg.
„ oxygonum *Sowerby*, Burnett River.
„ philippinensis *Desh.*, Normanton.
Dosinia corrugata *Chem.*, Gulf of Carpentaria.
„ lamellata *Reeve*, Yeppoon
„ subrosea *Lamark*, Keppel Bay.
„ turgida *Reeve*, Bundaberg.
Gafrarium divaricatum *Gmelin*, Bundaberg.
Cytherea dysera *Chemnitz*, Moreton Bay.
„ impudica, *Sowerby*, Normanton.
„ isabellina *Phillipi*, Moreton Bay.
„ lacerata *Hanley*, Bundaberg.
„ puerpera v. Gladstonensis *Angas*.
Macrocallista lilacina *Lamark*, Cardwell.
„ lusoria *Chemnitz*, Normanton.
„ pellucida *Lamark*, Torres Strait.
Chione Yerburyi, *E. A. Smith*, Caloundra.
Paphia analis *Phillippi*, Burketown.
„ inflata *Desh*, Moreton Bay
„ semirugata *Philippi*, Fraser Island.
„ tumida *Sowerby*, Moreton Bay.
„ turgida *Lamark*, Yeppoon.
Tellina deltoidalis *Lamark*, Moreton Bay.
„ imbellis *Hanley*, Eliot River.
„ rostrata *Linnæus*, Murray Island.
Donax australis *Lamark*, Caloundra.
„ tinctus *Gould*, Yeppoon.
Anapella cuneata *Lamark*, Caloundra.
Mactra contraria *Deshayes*, Noosa.
„ Cuvieri *Deshayes*, Bowen.
„ depressa *Lamark*, Bundaberg.
„ luzonica *Deshayes*, Caloundra.

Mactra meretriciformis *Deshayes*, Eliot River.
,, polita *Deshayes*, Moreton Bay.
Solen vaginoides *Lamark*, Yeppoon.

CEPHALOPODA.

Nautilus macromphalus *Sowerby*, Torres Straits.
,, umbilicatus *Lister*, Torres Straits.
,, stenomphalus, *Sowerby*, Torres Straits.
Sepia rostrata *D'Orbigny*, Moreton Bay.
,, Rouxii *D'Orbigny*, Moreton Bay.
Argonanta argo *Linnæus*, Torres Straits.

AMPHINEURA.

Acanthopleura spiniger *Sowerby*, Townsville.
Cryptoplax striatus *Lamark*.
Ischnochiton fruticosus *Gould*.

GASTEROPODA.

Scutus anatinus *Donavon*, Moreton Bay.
Subemarginula australis *Q. and G.*, Cairns.
,, parmophoroides *Q. and G.*, Caloundra.
Haliotis coccoradiata *Reeve*, Caloundra.
,, Cunninghamii *Gray*, Torres Straits.
,, Roei *Gray*, Cairns.
Trochus concinnus *Dunker*, Murray Island.
,, incarnatus *Philippi*, Torres Straits.
,, mauritianus *Gmelin*, Caloundra.
,, noduliferus *Lamark*, Caloundra.
,, radiatus *Gmelin*, Murray Island.
Clanculus Lischkeanus *Pilsbry*, Murray Island.
Monodonta zebra *Menke*, Moreton Bay.
Cantharidus (Elenchus) leucostigma *Menke*, Murray Island.
Gibbula magus *Linnæus*, Torres Straits.
,, Strangei *A. Adams*, Gladstone.
,, Coxi *Angas*, Gladstone.
Calliostoma picturata *H. and A. Adams*, Murray Island.
,, oberwimmeri *Preston*, Murray Island.
Euchelus baccatus *Menke*, Murray Island.
,, instrictus *Gould*, Murray Island.
,, mysticus *Pilsbry*, Caloundra.
Bankivia fasciata *Menke*, Moreton Bay.
Angaria laciniatus *Lamark*, Normanton.
Ethalia costata *Valenc.*, Murray Island.
,, vestiarium *L.*, Murray Island.

Turbo pulcher *Reeve*, Bowen.
,, setosus *Gmelin*, Gladstone.
,, stamineus *Martyn*, Bowen.
Astralium asteriscus *Reeve*, Normanton.
,, fimbriatum *Lamark*, Caloundra.
Liotia cidaris *Reeve*, Murray Island.
Nerita chrysostoma *Recluz*, Murray Island.
,, patula *Sowerby*, Caloundra.
,, polita v. antiqua *Recluz*, Yeppoon, Wide Bay.
* ,, signata *Macleay*, Murray Island.
† ,, squamulata *Le Guillou*, Murray Island.
Neritina pulligera *Linnæus*, Cairns.
,, Rangiana *Recluz*, Murray Island.
,, variegata *Lesson*, Bowen.
Tectarius bullatus *Martyn*, Cape York.
Phenacolepas granocostatus *Pease*, Murray Island.
Helcioniscus eucosmia *Pilsbry*, Caloundra.
,, tramosericus *Montrouzer*, Moreton Bay.
Rissoina deformis *Sowerby*, Murray Island.
Tatea rufilabris *A. Adams*, Tweed River.
Truncatella valida *Pfr.*, Murray Island.
Hipponix antiquatus *Linnæus*, Burleigh Head.
Calyptraea calyptræformis *Lamark*.
Cerithium Hanleyi *Sowerby*, Murray Island.
,, inflatum *Quoy*, Townsville.
,, lacteum *Kiener*, Murray Island.
,, tenellum *Sowerby*, Murray Island.
,, tuberculatum *Linnæus*, Moreton Bay.
,, tessellatum *Sowerby*, Murray Island.
Cerithidea Fortunei *A. Adams*, Yeppoon.
,, obtusata *Lamark*, Moreton Bay.
Pyrazus zonalis *Bruguiere*, Burleigh Head.
Siliquaria australis *Quoy and Gaimard*, Caloundra.
Strombus dilatatus *Swainson*, Torres Straits.
,, epidromis *Linnæus*, Cardwell.
,, floridus *Lamark*, Murray Island.
,, Isabella *Lamark*, Murray Island.
,, latissimus *Linnæus*, Torres Straits.

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* Given as a synonym of N. reticulata *Karsten*, but separated by E. A. Smith.

† Given as a synonym of N. chameleon *Linnæus*, but separated by E. A. Smith.

Strombus labiosus *Gray*, Torres Straits.
Struthiolaria scutellata *Martyn*, Yeppoon.
Pteroceras aurantium *Lamark*, Torres Straits.
„ chiragra *Lamark*, Thursday Island.
„ rugosum *Sowerby*, Torres Straits.
Pyramidella sulcata *A. Adams*, Murray Island.
„ variegata *A. Adams*, Murray Island.
„ ventricosa *Guerin*, Cardwell.
Fusus colus *Linnæus*, Torres Straits.
„ „ v. novæ-hollandiæ *Reeve*, Normanton.
„ spectrum *Adams and Reeve*, Yeppoon.
Architectonica areolata *Lamark*, Murray Island.
„ modesta *Phillippi*, Caloundra.
„ Reevei *Hanley*, Normanton.
Torinia infundibuliformis *Gmelin*, Caloundra.
Cymatium caudatum *Gmelin*, Caloundra.
„ doliarium *Linnæus*, Torres Straits.
„ nodiferum *Lamark*, Bowen.
Distortrix anus *Linnæus*, Burketown.
„ cancellatus *Deshayes*, Yeppoon.
Melongena pugilina *Born*, Yeppoon.
Bursa pulchra *Gray*, Caloundra.
Cassidea achatina *Lamark*, Caloundra.
„ Angasi *Brazier*, Caloundra.
„ rufa *Linnæus*, Murray Island.
Tonna costata *Meuke*, Torres Straits.
„ fimbriata *Sowerby*, Murray Island.
Harpa conoidalis *Lamark*, Torres Straits.
„ minor *Martyn*, Torres Straits.
„ nobilis *Martyn*, Burketown.
Natica maroceana *Chemnitz*, Murray Island.
† „ marochiensis *Recluz*, Moreton Bay.
Polinices citrinus *Philippi*, Torres Straits.
„ lactea *Sowerby*, Torres Straits.
„ maura *Lamark*, Murray Island.
„ rufa *Born*, Cape York.
„ Strangei *Reeve*, Bowen.
Sigaretus incisus *Reeve*, Moreton Bay.
„ papillus *Gmelin*, Moreton Bay.
Cypraea annulata *Gray*, Torres Straits.
„ brevidentata *Sowerby*, Caloundra.

† Joined to the preceding by Tyron, but separated by E. A. Smith.

Cypraea caput-anguis *Phil.*, Caloundra.
,, cicercula *Gmelin*, Murray Island.
,, (Amphiperas) concinna *Adams and Reeve*, Caloundra.
,, cribraria *Linnæus*, Moreton Bay.
,, cruenta *Gmelin*, Torres Straits.
,, histrio *Linnæus*, Cairns.
,, interrupta *Gray*, Murray Island.
,, mappa *Linnæus*, Gulf of Carpentaria.
,, neglecta *Sowerby*, Caloundra.
,, nucleus *Linnæus*, Murray Island.
,, obvelata *Lamark*, Cairns.
,, onyx *Linnæus*, Burketown.
,, pantherina *Solander*, Torres Straits.
,, poraria *Linnæus*, Wide Bay.
,, pyriformis *Gray*, Townsville.
,, reticulata *Martyn*, Cairns.
,, scurra *Chemnitz*, Torres Straits.
,, stolida *Linnæus*, Caloundra.
,, tabescens *Solander*, Murray Island.
,, talpa *Linnæus*, Torres Straits.
,, teres *Gmelin*, Murray Island.
,, testudinaria *Linnæus*, Torres Straits.
,, ventriculus *Lamark*, Torres Straits.
Trivia Childreni *Gray*, Wide Bay.
Ovulum Angasi *Adams*, Caloundra.
,, angulosum *Lamark*, Murray Island.
,, birostris *Lamark*, Caloundra.
,, lacteum *Lamark*, Yeppoon.
,, pyriformis *Sowerby*, Murray Island.
,, verrucosum *Lamark*, Caloundra.
Radius nr. seminulum *Sowerby*, Caloundra.
Scaphella Norrissi *Sowerby*, Cape York.
,, ,, v. Sophiæ *Brazier*, Cape York.
,, pallida *Gray*, Barrier Reef, Bowen.
,, piperita *Sowerby*, Cardwell.
,, reticulata *Reeve*, Gulf of Carpentaria.
,, Turneri *Gray*, Gulf of Carpentaria.
,, vespertilio *Linnæus*, Gulf of Carpentaria.
Cylindra nucea *Meuschen*, Bowen.
Oliva bicolor *Lamark*, Normanton.
,, bulbiformis *Ducloz*, Murray Island.
,, carneola *Lamark*, Murray Island.

Oliva elegans *Martyn*, Murray Island.
,, erythrostoma *Lamark*, Cape York.
,, funebralis *Lamark*, Murray Island.
,, guttula *Martyn*, Torres Straits.
,, inflata *Lamark*, Trinity Bay.
,, irisans v. fulgetrum, Murray Island.
,, mustellina *Lamark*, Normanton.
,, sanguinolenta *Lamark*, Torres Straits.
,, tessellata *Lamark*, Torres Straits.
,, tremulina *Lamark*, Murray Island.
Marginella compressa *Reeve*, Murray Island.
,, triplicata *Gaskoin*, Murray Island.
Terebra babylonia *Lamark*, Murray Island
,, cerithina *Lamark*, Cairns.
,, Dussumieri, *Kiener*, Bowen and Normanton.
,, mera, *Hinds*, Bowen.
,, monilis *Quoy*, Cape York.
,, nitida *Hinds*, Murray Island.
,, subtextile *Smith*, Bowen.
,, trochlea *Deshayes*, Normanton.
Conus aureus *Hwass*, Moreton Bay.
,, bullatus *Linnæus*, Burketown.
,, catus *Hwass*, Murray Island.
,, cinereus *Hwass*, Caloundra.
,, generalis *Linnæus*, Torres Straits.
,, gubernator *Hwass*, Yeppoon.
,, lithoglyphus *Meuschen*, Torres Straits.
,, luteus, *Brod.*, Burketown
,, miles *Linnæus*, Torres Straits.
* ,, minimus *Linnæus*, Murray Island.
,, monile *Bruguiere*, Yeppoon.
† ,, ochroleuca *Gmelin*, Port Douglas.
,, omaria *Hwass*, Torres Straits.
,, rattus *Hwass*, Caloundra.
,, stillatus *Reeve*, Dunk Island.
,, stramineus *Lamark* v. zebra, Torres Straits.
,, suturatus *Reeve*, Murray Island
,, tulipa *Linnæus*, Normanton.
,, vexillum *Gmelin*, Torres Straits.
,, virgo *Linnæus*, Torres Straits.

* s. Conus coronatus *Dillwyn*.
† s. Conus fasciatus *Martyn*.

Glyphostoma tribulationis *Hedley*, Hope Island.
Mangilia gracilenta *Reeve*, Hope Island
Pleurotoma babylonica *Lamark*, Cairns.
,, cognata *Smith*, Burleigh Head.
,, grandis *Gray*, Burketown.
Fasciolaria fimbriata *Linnæus*, Torres Straits.
Peristernia australiensis *Reeve*, Tweed Heads.
,, spinosa *Martyn*, Keppel Bay.
,, ustulata *Reeve*, Normanton.
Mitra adusta *Lamark*, Cairns.
,, aurantiaca *Chemnitz*, Moreton Bay.
,, cadervosa *Reeve*, Bowen.
,, cardinalis *Gmelin*, Murray Island.
,, discoloria *Reeve*, Murray Island.
,, Hainillei *Petit*, Cardwell.
,, luculenta *Reeve*, Murray Island.
,, papalis *Linnæus*, Torres Straits.
,, pontificalis *Lamark*, Torres Straits.
,, procissa *Reeve*, Moreton Bay.
Tritonidea australis *Pease*, Tweed Heads.
Engina zonata *Reeve*, Murray Island.
Arcularia australis *A. Adams*, Murray Island.
,, cancellata *A. Adams*, Murray Island.
,, concinna *Solander*, Townsville.
,, ecstilba *Mell. and Stand.*, Murray Island.
,, glans v. elegans *Reeve*, Caloundra.
,, globosa *Reeve*, Torres Straits.
,, Jacksoniana *Q. and G.*, Caloundra.
,, Jonasi *Dunker*, Moreton Bay.
,, monile *Kilver*, Cape York.
,, labecula *A. Adams*, Bowen.
,, subspinosa *Lamark*, Normanton.
,, tiarula *Kilver*, Townsville.
Pyrene discors *Gmelin*, Bowen.
,, Filmeræ *Sowerby*, Murray Island.
,, fulgurans v. punctata *Lamark*, Murray Island.
,, jaspidea *Sowerby*, Murray Island.
,, pulchella *Sowerby*, Murray Island.
,, mariæ *Brazier*, Murray Island.
,, mercatoria *Linnæus*, Bowen.
,, Tayloriana *Reeve*, Murray Island.
,, Tyleri *Gray*, Moreton Island.

*Pyrene zelina *Ducloz*, Caloundra.
Murex acanthostephes *Watson*, Normanton.
,, Bednalli *Brazier*, Normanton.
,, haustellum *Linnæus*, Torres Straits.
,, monodon *Sowerby*, Burketown.
,, osseus *Reeve*, Normanton.
,, pyrum *L.*, Cardwell.
,, torrefactus *Sby.*, Gulf of Carpentaria
Afer Blosvillei *Deshayes*, Caloundra.
,, carinifera *Lamark*, Normanton.
Thais ambustulatus *Hedley*, Moreton Bay.
,, bufo *Lamark*, Yeppoon.
,, haemostoma *Linnæus*, Moreton Bay.
,, intermedia *Kiener*, Keppel Bay.
,, pica *Blainville*, Torres Straits.
,, succincta v. textiliosa *Lamark*, Caloundra.
Drupa biconica *Blainville*, Murray Island.
,, grossularius *Bolten*, Torres Straits.
,, horrida *Lamark*, Torres Straits.
Plecotrema lirata *H. and A. Adams*, Burleigh Head.
Ophicardelus australis *A. Adams*, Brisbane River.
Melampus castaneus *Muhl.*, Bowen.
Bullina lineata *Gmelin*, Caloundra.
Bullaria ampulla *Linnæus*, Bowen.
,, ,, v. bifasciata *Menke*, Bowen.
,, australis *Q. and G.*, Caloundra.
Haminea galba *Pease*, Murray Island.
Hydatina albo-cincta, v. *d. Hoeven*, Stradbroke Island.
Hexabranchus marginatus *v. Gräff*, Hope Island.

SCAPHOPODA.

Dentalium elephantinum *Linnæus*, Torres Straits.
,, katowense *Hedley*, Murray Island.

BRACHIOPODA.

Lingula hians *Swainson*, Moreton Bay.

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* Considered by Tryon to be a form of P. discors *Gmelin*.

A BORA RING IN THE ALBERT VALLEY.

By JOHN SHIRLEY, B.Sc.

(Senior Inspector of Schools).

Read before the Royal Society of Queensland, 24th September, 1910.

In my experience of thirty-three years, during which I have held the office of Inspector of Schools, it has been my duty to travel over the whole of the inhabited portion of Queensland. For twenty years this work was done almost solely on horseback, with long periods during which it was necessary to carry packs, tent, and provisions, and thus an intimate knowledge was obtained of that part of Queensland sufficiently inhabited to require schools. It has often been my good fortune to discover and examine the so-called *kipper* or *bora* rings. In each instance these comprised two earthen rings, whose diameters were in the ratio of 3 : 8, or 1 : 2, connected by a path, generally 5 feet wide and 4-600 yards long.

In the South-east Moreton District I know of four of these bora rings; one at the junction of the Mudgeraba and Gilston Roads, not far from the Nerang railway station; the second at Munninba, between the selections of Hon. J. G. Appel and Mr. Alexander Duncan; the third about a mile east of the Canungera Mill, at the junction of the Pine Creek and Coomera River Roads. The fourth, which is one of the largest I have ever seen, and differs from all others examined in several important particulars, is the subject of this paper.

It is on the eastern bank of the Albert River, at Tambourine Village, on Mr. Henderson's farm, and about a quarter of a mile from his house.

The site is in sandy soil, on a flat ridge rising 30-40 feet above the Albert River. The first ring is 80 feet in

diameter, looking like an immense circus ring, with walls which are now two to three feet above the surrounding level, and almost uniformly five feet thick at the base. In this ring trees of nine inches in diameter are growing, showing that it has not been used for some years past.

Leading out of the large ring at its southern side is a path, now partly overgrown with grass, and varying in width from 2 to 5 feet. This path is 400 yards long, and is in a north and south direction.

The path ends in a second ring, 30 feet in diameter, resembling the first, but with rather less solid earthen walls. So far this "kipper ring" resembles in plan all others yet visited; but guided by Mr. Henderson and Mr. B. Geissmann, of Capo di Monte, Tambourine Mountain, it was seen that from the southern side of the small ring the path continued for another 400 yards, where it ended in a third wall of earth, this time of an oval shape.

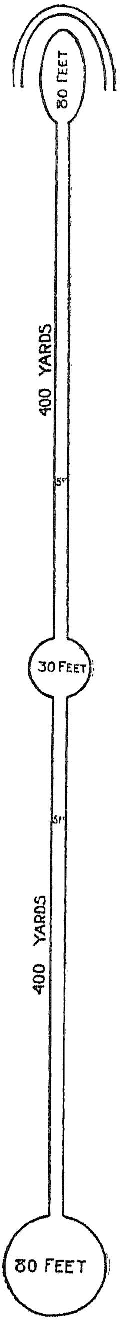
This oval enclosure measures 80 feet long by 30 feet in its widest part. The long axis lies in the same direction as the paths, almost exactly north and south.

Mr. Thos. Petrie in his "Reminiscences of Early Queensland," has given a graphic account of the Bora ceremony, as practiced by the tribes in the neighbourhood of Brisbane, pp. 44-57, with a plan of one of the rings on p. 49. But neither in his book, nor in any other work on Queensland aborigines, have I found mention of the third earthen enclosure to which I have referred.

Round the third or oval earthen rampart is a semi-circular track or path, roughly shown in the plan. Unfortunately in the Albert Valley to-day there are only a few half-castes remaining, and from these it is difficult to obtain any information as to tribal customs.

All writers on the "kipper" initiation ceremony describe the tribal fights that took place at its close; first the fights between the initiated boys, then the melée in which parties of tried warriors distinguished themselves, and finally the single combats between tribal champions. It is the general belief in the Tambourine neighbourhood that the oval enclosure was the scene of these Homeric contests, and that the semi-circular track surrounding it was beaten by the feet of the tribesmen of combatants when cheering on the champion of their tribe.

When one considers the tools used in raising these structures were merely pointed sticks and stone tomahawks, and that the earth was carried on sheets of bark, one marvels at the energy and persistence of a race generally regarded as one of the lowest in the scale of humanity.


80 FEET
400 YARDS
5 ft
30 FEET
5 ft
400 YARDS
80 FEET

ANTHROPOLOGICAL NOTES OF 50 YEARS AGO.

By R. CLIFFE MACKIE.

Read before the Royal Society of Queensland, November 26th, 1910.

As an old colonist and one whose occupation brought him in contact with the blacks while they were still numerous and while they still retained their original customs, I have thought it might be interesting and useful if I placed on record what I observed among them. This will soon be impossible for men of the present day, for the blacks are now few in number, and it hard to find a district where the blacks retain their old customs unaltered by contact with the white man.

My memory dates back nearly sixty-six years. From the year 1850 up to 1867 I lived principally upon the outskirts of civilization, engaged with others in establishing cattle stations on suitable areas of recently explored country, and thus necessarily came in contact with the blacks while yet unaltered by contact with the whites in the settled districts. Being young and impressionable I took a deep interest in their ways and customs. As soon as new "runs" were occupied, the blacks began dimly to grasp the new situation. They appointed one of their tribe, who had passed through the usual "Bora" ceremonies, to investigate as to the "whitefellow" and his ways. This the black did by volunteering to assist in droving the first lot of fat stock sent from the neighbourhood to market. His services as tracker were most useful in following up cattle that had strayed off the camp during the night or had "rushed" owing to a thunderstorm or any other cause of fright. Having thus made himself indispensable to the camp, he, during a trip of some hundreds of miles in length and of some months in duration, allowed nothing to escape him which was of consequence to his race.

Some of their inferences were very amusing. A Moonie River "boy," who accompanied a drover to Sydney, was taken by him to the theatre. The piece was a tragedy, and as a *finale* the heroine was stabbed by an assassin. The dagger used was of the usual "telescoping" kind, and liquid, representing blood, dripped from the blade. Combo stood up in great excitement, and amid the dense silence, cried out in broken English, "Well, well! Stupid white-fellow, to kill that budgeree (*i.e.*, good) young woman! I want to go home!" On my telling him it was not real, he replied, "I saw the blood on his knife." The curtain fell with the drover, Combo and myself the cynosure of all eyes. I saw this same man about five years afterwards on the Balonne River. He told me he had just returned from North-west Queensland, having spent the whole intervening period fulfilling his mission. Knowing the interest I took in blacks' ways, he told me his adventures, and, as was the custom in those days, I took him on as a sort of "Man Friday."

The account he gave me was, as near as I can now remember, as follows:—The news of his return from Sydney had soon spread far and wide, and he was required at all corrobborees in order to recount to the other blacks what he had learned.

The listening blacks carried the tale to more distant tribes, who wished corroborative evidence. Their etiquette ran thus: —

A general meeting was convened at some rendezvous, and at dusk the fires were set blazing. The narrator left the circle and took up a position directly opposite to where the leading men of the community are stationed. One of the "elders" then calls out to him, "Where did you come from?" He replies by naming the last place at which he spoke. "Where are you going?" To this he replies that he is going all about with news because he has seen the white-fellows' camp and the "big waterhole" (*i.e.*, the sea). A general request is then made for him to unfold his tale. Choosing a position so that his voice can be heard through all the camp, and addressing himself to the leading men, he tells all he knows. As this is the universal practice among them, and as in this way the news of Governor Phillip's landing and the outbreak of the gold

diggings would be carried over the Continent, all tales of men who speak of having met tribes that never had heard of or seen white men must be received with extreme caution. I myself met, 40 years ago, blacks who declared that they were a "moon's journey" from their own "towrie" or hunting-ground. It is very hard to get reliable information as to their ways. They distrust and stand in awe of adult whites and will not reveal much to them. They are more free with young white boy and girls, but the latter are not prone to ask for information of the kind indicated nor to understand it when given. Besides, blacks would be very unlikely to discuss such topics with children too young to be told of such matters. It might be a matter of wonder why those white men who have lived among the blacks for years can or will tell so little about them. As a matter of fast, such whites are merely kept as curiosities by the blacks, just as we keep a strange animal in a "Zoo." As the novelty wears off, the prisoner is relegated to the society of the "gins" and "piccanninies," and he is allowed no part in tribal discussions or initiations. This humiliating treatment, which is very keenly felt, makes the white prisoner on his return to civilization unwilling even to talk of matters which revive the galling memories of his past treatment. Such men are never allowed to learn anything of the matters and ceremonies affecting adult blacks, nor would they be very likely to tell if they did know. They resent any inquiries which would lead to the disclosure of how completely they had been ignored.

It is probable that the race at one time were of a higher intelligence and civilization than now. Those who instituted their social and marriage rules must have been of a higher type than the savages that Captain Cook met. The present natives could scarcely invent the laws relating to marrriage and consanguinity nor those relating to their social economy. There are many of their rules which remind one of the ancient Hindu and Thibetan rules. Whether similarity of social rules implies a similar racial origin is unsettled.

With regard to their origin they have no theories to offer. Even with regard to their own individual existence, all they can suggest is that their "totem" in some way influences the circumstance. With regard to their charac-

teristics, it may be remarked that treachery is so common among them that they, from fear of an attack from an enemy, are habitually light sleepers. The circumstances of their lives make them keen observers, though this characteristic diminishes after long residence with white men.

Most of the young men are vain, and like to decorate themselves with gaudy feathers, shells, pipe-clay, ochre, or anything of a showy nature. The "gins" (except when being young they are given to these decorations) rarely indulge in such frivolities.

The men have no conception of feminine beauty in the sense in which we understand such a feeling; and have no sense of conjugal love. They treat their children indulgently till the age of puberty, after which they abandon them to their own resources.

Taken generally, they are a laughter-loving people, and generous to a fault. The narrow range of their ideas is, no doubt, responsible for their taciturnity, and this may account for their limited vocabulary, which makes them represent by a difference in emphasis rather than by a different word any different shade of meaning. This is especially the case with the "gins" when excited. Their language is pronounced with a marked nasal intonation. They had no recognised chief. Each man had influence according to his force of character. There were no tribal boundaries beyond the usual habits of remaining on a known hunting ground. An illegitimate could go to the next tribe, select a wife and marry. He would not be killed as an alien. Wounds were healed by an application of mud, and their flesh heals rapidly. They survive wounds which would end white men. For bowel troubles they use "apple-tree" gum, or the gum from some other eucalypt.

When forced to go hungry they gradually tighten a belt of opossum hair round their stomachs, and this moderates the pain of hunger, or, at any rate, makes it less keenly felt.

The mothers are very fond of their sons, and on the return of a son after a long absence, the mother sits in front of him, puts her hand on his knees, and, looking pleadingly up in his face, says, "Ti on naa, nia berahli" (Come to me, my child).

A messenger carrying news to other tribes, before he camps for the night, will cross the top end of the water-course, follow down to the lower end, and re-cross. This latter manœuvre is supposed to leave behind any malignant spirit which may have dogged their footsteps.

A myall (wild black) will not follow walking behind a white whom he loves lest his savage instincts should lead him to take a treacherous advantage.

They are not cruel, but, like children, are incapable of mental sympathy. They will not drown or kill puppies, but will put a whole litter into a hollow stump and abandon them to show starvation without compunction. They seem to form no mental conception of pain which they do not actually see or hear.

It is not true that they abandon their aged or infirm to die of starvation. In all cases such victims were voluntary martyrs, who, owing to senile decay, became despondent, and, at their own request, were taken to the neighbourhood where they wished to die, the whole camp demonstrating in various ways their sympathy.

Upon arriving there, the patient was laid on his sleeping apparel with all his worldly goods. His friends then departed, and the patient, by the mere exertion of his will-power, died off in a sort of stupor or sleep, because he had willed to cease living. It was only those from other tribes, who, unable to brook the restrictions of the white invaders, left their own hunting-grounds and sought an asylum along their neighbour tribes that were left to die neglected. As they had no blood relations, they were left to meet their end as best they could, a tribal law forbidding sympathy to one who was not of their tribe. But those of the same "totem" might, by consent of the tribe, bury the stranger. No other blacks would venture to do so, lest some evil might befall them. The stranger was generally buried, it may be remarked.

A man or woman might only marry according to certain prescribed "groups." If a young gin were the destined mate for a certain black, he allowed her to run about as she pleased just as any mere animal might do till such time as he felt inclined to claim her. From this time on, she was for him alone. Should there be a piccaninny which, owing to this prior freedom of conduct, he did not consider his,

he refused the midwife all countenance for the child. The midwife then went to the mother who had gone through her confinement at a spot some distance away, and intimated that the child was unwelcome. The little stranger then disappeared as not wanted; so generally did one of twins. It is worthy of remark that the old midwife generally pleaded hard for the child till the blackfellow indicated by an angry reaching for a nulla-nulla that he was weary of the subject, and would knock on the head perhaps her, the piccaninny, or both if she worried him much longer. Sometimes a black through jealousy refused to have the child saved. Crippled or deformed babies might be killed.

It is not true, on the Darling and Murray waters, at any rate, that piccaninnies were killed when food was scarce or when the tribe had a journey to go. I do not presume to speak for districts unknown to me in this connection. The husband might have one or two wives, but they must be of the prescribed "group." He would lend one for any time, short or long, to a visitor from another tribe, provided the visitor were not of the wrong "group"—this to avoid consanguinity. There is a remarkable similarity to Mahometan customs as regards divorce. They can divorce a wife, and, if all parties are agreeable, make them eligible to re-marry. First cousins may not marry. The children of such marriages and of marriages in prescribed "groups" are treated as illegitimates are with us. A front tooth is knocked out as a brand, and the outcast may marry in another tribe, or, if a gin, may become the property of a low white or a Chinaman. The low white or Chinaman prefers such a gin, as no blackfellow is likely to come and dispute possesion with him, nor is any visiting black likely to coax her away for a wife, as the tribe to which she belongs would favour the white man or Chinaman.

No "illegitimate" may marry in his or her own tribe. The parents marry their girl to a suitable man. She is not consulted. Two men may exchange wives or barter them.

Grown-up sons are expected to provide for their mother, and according to their lights they do so. The old men are kept in the camp with the gins, who carry them if necessary.

Should any infant die, the mother must carry the corpse about with her for a certain time, according to the social order, before she buries it. The succeeding menstrual

period frees her from the obligation. The burial rites differ according to the several " castes " of consanguinity. Some are put into a hollow tree which is still standing. Others are tied neck and heels and placed face downwards in a moderately deep hole, or they are laid in a shallow trench and covered over with leaves, earth, and long heavy saplings to save them from carrion birds. Dingoes, it is not generally known, will not eat human flesh. A grave was indicated by a single " blaze " on each tree in a circle round the grave. They had neither fear nor reverence with regard to such burial spots, but would not walk over a grave. One observance is purely religious. A dead warrior is put on a wooden frame and placed over a smouldering smoking fire. The mourners rush up to the corpse and rub the oozing grease from the corpse over their own breasts and limbs. This is done to set free and send his soul away so that it will no longer follow them.

In no instance on the inland waters did cannibalism obtain. The blacks would, however, eat stale eggs, putrid flesh, loathsome insects, etc.

Like the ancient Egyptians, as seen in hieroglyphs, they used " message sticks." Certain characters were cut into the message stick to assist the memory of a tribal delegate visiting another tribe on public affairs.

They made effigies—such as a miniature snake—and these were used from the Condamine River to the Murrumbidgee River at all religious ceremonies. The " Thoroo Mullion " or " bull-roarer " was only used at " bora " ceremonies.

They do not eat the animal whose " totem " they wear, but the rest of the tribe may, as it is only a social " taboo "—of breaking which they would feel greatly ashamed if detected.

They ate the grubs from the wattle trees, also the little yellow " hypoxis " yam. They would not eat the lily root as it made them sick, but they did eat the seed pod of a big lily in the " Nangram " waterhole. This is a big lily, sometimes blue and sometimes red, which grows about 6 miles below Fairy Meadow on the Condamine River. This pod when ripe bursts with a great " pop." They ate a big yam—the " Weeah "—which has a running vine. The cattle " ate this yam out " by eating the vine down

persistently. It was found by tapping with the foot on the ground. It grew about 12 inches below the surface, and was best when from a year to eighteen months old. It was so juicy as to be as good as a drink on a hot day. They ate white ants, bee larvæ, and bee bread.

A "possum-belt" or loin cloth was worn, but by the young gins only. The males wore nothing. A stranger guest at a ceremony was distinguished by a few strips of kangaroo tail before and behind.

The septum of the nose was gradually dug through with the little finger nail, and a quill inserted. This was considered a great decoration.

The "humpies" were called "gundis," and were made of bark. Goondiwindi (the town) simply means "the hut on the water hole."

They used no "woomerah." They had the ordinary light currajong "heelaman," also a special "heelaman" for warding off boomerangs. Certain blacks were the recognised weapon-makers. The stone tomahawks were sharppened by water and friction. One of their "grounds" where these were prepared lies about 100 yards below the old house at Cobboreena, on the west of the Creek. The "dilly-bags" were made of Xerotes, which the gins scorched while it was green, and, after a month, they pulled it up, dried it, and used it.

Currajong fibre was beaten out, steeped in water and mud, and made into "dilly-bags." Kangaroo sinew was used for sewing opossum rugs. The "reed-spear" was unknown, brigalow being used.

The "weet-weet"—a sort of torpedo-shaped stick—was used in play. One man held a small green twig or branchlet about three feet above the ground. Another jerked the weet-weet through this, and the toy often flew 300 yards, the tail controlling its flight. They are guided in making their appointments as to religious ceremonies, etc., by the movements of the more conspicuous heavenly bodies, as Orion's Belt, but a moonless night is always chosen for such ceremonies. The Milky Way and Magellan's Clouds are watched, but the Moon and Orion's Belt are, in that order, their chief guides as to times and seasons for social functions. They take interest in Venus as an evening star, but fail to recognise her in the morning.

They are afraid when an eclipse occurs, and include it with meteors and whirlwinds among the malignant spirits which they propitiate by making a peculiar kind of noise. When a blood relation dies, they note the position of some planet, and when that planet again returns in its annual course they renew their mourning and cry without shedding a tear. They think all the stars, planets, etc., are alive. They had several religious and social ceremonies. The "corrobboree" was more of a social character, and a great "Borah" was their *great* religious ceremony. The word "Bora" means a place where religious functions common to the community may be carried out. On the Murray River basin and all its tributaries a grand bora was held about every 10 years. The time and place were arranged according to conditions of weather. No hunting is carried on in that place for at least a year, that there may be game enough to supply the assembled tribes while the bora lasts. As the time draws near, all the tribesmen within a reasonable distance visit the spot and help in the excavation. They use yam-sticks to loosen the soil, and, commencing from the centre of the ring with flat pieces of wood or tough bark for shovels, they throw the dirt between their legs behind them towards the outer rim of the circle which is to encompas. the sacred ground. They usually excavate about six inches of the surface soil, which they ultimately form into a mound to represent and define the ring. Within speaking distance is a much smaller circle, where the neophytes must wait till called by the elders.

The Kamiloroi tongue is used in these functions as being commonly understood by all the Western tribes of whatsoever dialect they be.

The Neophytes are taught how to throw bundies, boomerangs, weet-weets, nulla-nullas and spears. They are taught weapon-making and rude blacksmithing. They get a secret family name, which, however, eventually leaks out by accident. The indispensable knack of quivering the muscles of the arms and thighs as shown at corrobborees is taught here.

Weapons were bartered. Marriage disputes were settled and questions of consanguinity. Illegitimates had a tooth knocked out. All private and public disputes were argued out. No tribe had a chief. Each man's opinion

carried weight according to his earnestness on the question and his force of character. These outings sometimes lasted for months, each tribe inviting the other to its "towrie" or hunting ground. Idolatry was unknown either at boras or at any other time. Effigies were used, but not worshipped. The "mysterious observances" talked about have no foundation in fact. They have no theories as to a future life. The "die blackfellow, jump up white-fellow" is a white man's importation. They believe in the presence of departed spirits and do not like to name a deceased person. Their grief at a death is very demonstrative and noisy, and is accompanied by their cutting themselves with mussel shells and sharp flints. They have no idea of God. All their "theology" is associated with evil spirits supposed to inhabit the heavenly bodies, thunder, lightning, meteors, shooting stars, etc.

Their ideas and ceremonies vary somewhat in different tribes, just as do our own religious sects. In the North the bora ring is an area like a rabbit-warren; the large and small circles of one tribe and the two equal circles of another being merely differences in matters of form. The root principles are the same.

The extraordinary lengths to which these bora practices sometimes run have a parallel in the religious frenzies seen among our own race at times.

The "Yo-Yo" bora ceremonies of the Barwon River are almost identical with the "Wom-nay-narah-narah" of Cooper's Creek.

The cutting off the top joint of the little finger and the piercing the septum of the nose are of social and not of religious significance. Pipe-clay marks on a gin had a medico-sexual import, not a religious one. The corroboree serves as a history or record of political and domestic events, and is an easy way of spreading local gossip to the other tribes. To send unwelcome rain away, all the men gathered kneeling in a ring round a "charm"—a water-worn stone—and for half-an-hour repeated "Wee yan Burran" (Go away, rain). If the rain went, faith in the "stone" increased; if not, some other tribe was praying for the rain to continue. With the advent of the whites, and the dying out of the blacks, boras and corrobborees are neglected and forgotten. The marriage and other laws

of the blacks are becoming confused and forgotten. Their "group" distinctions are dying out, and they no longer take the chance of learning the arts peculiar to themselves, as these are fast becoming needless with the advent of white man's food, weapons and laws.

Only the low-class whites will fraternise with the blacks, who, therefore, learn nothing of us but our vices. The contact with the lowest stratum of our race has not been a benefit to the aboriginals. All honour to those who have endeavoured to preserve, help and teach them. As their visual and other sense organs are the faculties most developed in them, any attempt at teaching them should be directed to an appeal through these channels rather than through mental processes beyond their grasp.

I append a list of native words with their meanings, as these are often of interest to present day readers.

Billa	=	Waterhole, as Wallumbilla, Bogrambilla, Yulabilla
Dilla	=	Waterhole, Manandilla,
	=	Armadilla, Muckadilla.
Kobble	=	Waterhole, Kobble, Kobble, Cobblegun.
Bumba	=	An angle in a creek
Cooroora	=	Big waterhole with rocks in.
Euroka	=	Sun.
Goodar	=	Pine on one side of the water and box and coolibah on the other.
Ba	=	Waterhole, = Whyenbah, Tarawinnabah, Ibbinbah, Wallanbah. Whyenbah = Waterhole between two high ridges. Wallan = Bendee country. Ba = Water.
Quey Bunda	=	Red Kangaroo.
Denown	=	Emu.
Yeppi	=	Carpet Snake.

Mundowie	= Foot.
Mil	= Eye. (Innu-gomille = you see).
Binna	= Ear (Innu-binna you hear).
Numba	= Mother.
Banjamin	= Husband.
Meranjan	= Wife or woman.
Beerahli	= Picanninny, child.
Goleer	= Borrowed wife, sweet-heart, or rejected wife.
Geer	= Yes.
Kamel	= No (in Kamilaroi tongue).
Waal	= No (in Wallaroi tongue)
Boie	= Die.
Thaluma	= Thunder.
Boorae	= Fire or Lightning.
Collie	= Water (Umbercollie).
Collie Mungul	= Big waterhole.
Ki-i	= Excessively amorous.
Goona	= Excrement
Keel	= Urine.
Andillo	= Blackfellow
Bogal	= Stranger blackfellow.
Myall	= A black who knows nothing of white men.
Beer	= One.
Bullah	= Two.
Cooleebah	= Three.
Tallah Inneu Ti Annowin	= Where have you come from ?
Tallah Inneu Yan Nowie ..	= Where are you going to ?
Tanno Qui Qui Arrathy ..	= The other side of some red ground.
Auga Mundi	= Gather round. The "bora" ground of the white writers. ("Bora" is not a blacks' word.)
Niah Inneu Bunnaguy ..	= I and you go.
Bundagie	= Fall down.

Innu Kunmullie	=	Let go, you.
Kuckill	=	No good (anything objectionable).
Weaarree willijoe	=	we'll sit down.
Ti Una	=	Come here.

MARRIAGE CODE AND LAWS.

Brothers :	*Sisters* :
Cubbee	Cubbatha
Hippi	Hippatha
Murri	Matha
Combo	Bootha

Cubbee	Marries	Matha
Hippi	Marries	Bootha
Murri	Marries	Cubbatha
Combo	Marries	Hippatha

Children take their parents' names according to their group; and also their totem appellation, which is exchanged for their group name, when they obtain puberty.

NOTES ON A BRUSH-TONGUED MOSQUITO.

By W. R. COLLEDGE.

Presidential Address, read before the Royal Society of Queensland, 25th February, 1911.

Ladies and Gentlemen,—

You have heard from the Report that the year has not been unfruitful. Our late Premier was reported to have asked if the Royal Society was alive. The best answer to that will be the substantial volume of the proceedings which will soon issue from the press. It will be found more bulky than some of its predecessors. This is partly the result of kind contributors, the efforts of our very energetic Secretary, supplemented by members of the Council. But if the half of those who have been appealed to had responded in the affirmative, the result would have been a still more bulky volume as the evidence of our existence.

Only those who have sought to secure such work as is desired by the Royal Society know the difficulty that exists in obtaining original contributions. A trouble that is not peculiar to our State; for I note in the last report of that old-established Microscopic Society of London, the "Quekett Club" (of which our Bacteriologist, Mr. Pound, is a member), that they complain of the same difficulty; and regretfully say that if more original papers are not forthcoming, then the usefulness of their valuable magazine will be much curtailed. This is somewhat surprising, considering that the age is one of intense activity. There has never been as much scientific work done, in the same time, in any previous age, as in the present. All the world over, more men are occupied, who possess wider knowledge and more finished equipment than they ever had before. New fields of work are continually opening

up; many of these are occupied; the work is being done, but a great deal of it does not seem to come to the Societies which exist for its furtherance and development. We are sometimes tempted to ask are these bodies getting out of touch, or sympathy, with their mission, so that the workers do not receive from them a warm hand grip, and an encouraging word, and for want of them, keep aloof. That at least is not the case with the Society here. Its Council are only too glad to welcome all work that bears on it the stamp of originality. We have suffered somewhat from our inability to present, what we do get, in a better illustrated form. In bygone days a Government grant enabled us to secure engravings to illustrate adequately some of the subjects read at our meetings. But when, in darker times than these, the knife of retrenchment ruthlessly lopped off that source of revenue, and we had to depend only on members' subscriptions, then as honest men, making the Society pay its way, we did our best to keep the flag flying, but could not afford expensive engravings for the illustration of papers, and on that account some work done in this State is said to have gone to others who were able to furnish them in a superior style. That has told against us, and other States have gained credit for work which otherwise might have appeared in our pages. But we believe that better times are coming. The establishment of the University in Queensland; the gathering of the most gifted of our youths from all parts of the land must give an impetus to scientific work.

The presence of Professors and teachers, who having won laurels in other lands, and now make this fair city their home, cannot but have a powerful uplifting force. Their sympathies must be with us. And as, amid their onerous duties, some at least occasionally will be able to grace this platform, they will give the Royal Society a deeper inspiration, and make it a mightier force than it has ever been before.

To-night I wish to bring before you some interesting features of one of the species of mosquitoes found in our neighbourhood. Certain kinds of these insects are known to carry very serious diseases, and the whole family are re-

garded with suspicion. But the one I refer to is of a blameless character, and probably the whole of the group to which it belongs are likewise harmless to humankind. They belong to the genus *Megarrhina* (R. Desvoidy), and are distinguished from others by their generally large size, brilliant coloration, peculiar shape of proboscis, and the possession of a caudal fan. Tropical and subtropical regions are their homes. Giles in his book enumerates fifteen species. They have been found in the Argentine, Brazil, Sikkim and Central Asia, Java, Batavia, Island of Formosa. Alfred Wallace notes them from Singapore, the Celebes Islands, New Guinea and Queensland. So far only one of the species has been reported from this State. They range from Thursday Island, Port Denison. Mr. Tryon found them on Percy Island, Dr. Bancroft at Caboolture; and I have got larva from North Pine and Milton.

Sufficient material to make complete dissections of all parts of the body have not been available, but the little I have done is both interesting and instructive. This particular species was called *Megarrhina speciosa*, but Mr. Theobald, the authority at the British Museum on the Diptera, has rechristened it *Toxorynchites speciosa*, so that it is now known by that name.

On the 8th March, 1910, Dr. Parry (whose recent decease we greatly lament) brought down to me a living female specimen caught ten miles from Brisbane. This was the first living one I had seen. The next night it deposited on the water in its prison house a few eggs. These were laid, not in a raft like the house mosquito, but separately on the water. They are oval, measuring the 50th of an inch in length by the 42nd in breadth. The micropyle is at the centre of one end, and the shell splits centrally through its long axis for the emergence of the larva. The eggs are pale in colour, do not darken by exposure to the air, like some species, and the surface is finely granulated. In two days they hatched, and the larva, pale and transparent, lay on the surface of the water. I thought from their appearance and absence of motion that they were cast off skins, until on touching one with the point of a needle, it gave a twitch, and I found that they were the new born larva of this particular species.

The larva of many species are characteristic, so that

they can be recognised by anyone who has studied thire peculiarities. In the *Toxorynchites speciosa* the head is small, rectangular in shape, with a short unjointed palp projecting from either cheek. The thorax is about twice the length and breadth of the head. Three sets of short feathered balancing hairs spring from stout conical papilla on the sides. These bend towards the head. On the abdominal segments are similar papilla bearing much longer tufts of bristles. The terminal segment in the new born larva is longer and carries four very long seta, which are replaced in the next moult by a different form of appendage. In three or four days the colour becomes yellow. I found to my sorrow they were cannabilistic in practice.

I placed in clean water so that there should be no insects to do them hurt. But they preyed on one another, and it became a question of the survival of the fittest. On returning from business at night, I found only two alive, one seriously injured. He had received a bite through the chest which severed one of the main tracheal tubes, and notwithstanding careful nursing he died in three days.

The survivor was much more robust, and as the effect of his orgies, grew so as to require a new suit of clothes, for he moulted on the fourth day. This did not make any alteration in his appearance excepting in the tail appendages. In some species the difference is much marked, so that before and after the moult they look like two different species. Here the only change was in size and the tail fan. On the fifth day, granules of dark pigment began to appear, turning the general colour reddish brown, though the abdomen remained much paler. I regularly fed it on the larva of other mosquitoes, which it seized in characteristic style. First it displayed an aspect of perfect indifference to their presence. Not a muscle moved nor a balancing hair turned. It might be a floating splinter of wood for any sign of life. The other larva might swim round and almost touch it, but there was no sign of anxiety to cultivate a closer acquaintance. Thus all fear they might at first have at its presence subsided. By-and-bye, however, it would sidle up with a slow motion, watching intently with the head sloping downwards, the tail being attached to the surface film. Remaining motionless, it measured the striking

distance. If not quite near enough, then there was no muscular motion of the front part of the body, but the three last segments of the abdomen were quietly telescoped into each other, then outhrust, thus bringing him a little nearer. This generally took some time. And as ordinary larva are of an active nature they frequently moved to another place. But, with indomitable patience, the same process was repeated, again and again. Until at last the chance came, there was a flash from the seemingly inanimate body, and the larva struggled in his grip. Seized sometimes by the middle, occasionally by one of the palps on the head, there was no escape from those relentless jaws. Gradually it was drawn in, chewed bit by bit, until all the juices were extracted. Skin and crushed organs were then thrown aside, and in an hour or two the same process was repeated, and so several larva were disposed of every day. It did not entirely confine itself to mosquito larva, for a moth accidentally singing its wings at the lamp fell on the water of its preserve. Like a trout at a fly it rose, seized and dragged it down. I regularly fed it with mosquito larva obtained from various sources for the succeeding months, but the cooler weather retarded its development, and it was not until the 27th of August that it threw off its larval skin and entered into the pupa stage. Then it was 24 weeks old.

The pupa, or next stage of the insect, is distinguished from others of the family by its comparative size. They are veritable giants. Mr. D. O'Connor showed me one which had been sent to him as a curiosity some months ago. They are heavily built, chocolate brown in colour, and chiefly spend their time lying on the surface of the water. The cephalothorax is at first triangular in side view, but as the insect develops within, the lower portion grows as far as the third segment of the abdomen.

On the nape is a large tuft of palmate hairs, which, by laying hold of the surface film, helps to steady its body on the surface of the water.

It now breathes from the head, instead of the tail, as in the larval state, and the two spiracles or breathing organs are placed one on each side of the head. They are of the same dark chocolate colour as the body, but the internal surface is golden, contrasting beautifully with the darker background.

The connecting membrane of the segments, as in the case of the larva, is of a pale and flexible character. At the end is the telson or swimming appendage, composed of two broad fans. These diverge from each other more decidedly than they do in the pupa of other species with which I am acquainted. A stout rib passes down the centre of each leaf, and they are studded with minute hairs. The pupa stage continued for fifteen days; the perfect insect emerged on September 8th; the period from egglaying to perfect insect, being six months. This is probably much longer than it would have been in a natural state. In artificial conditions, mosquitoes require a much longer time to pass through their life changes than if they were placed in natural conditions. But this is the only instance where I have been able to breed from the egg to the perfect insect.

The adult insect is the largest and most handsome of all the species. The body measures three-quarters of an inch in length, and when the legs are extended from the sides, they cover a space of an inch and a half. So that it is a veritable giant in its tribe.

Not only is it distingiushed for size, but likewise for beauty. The black eyes are bordered by silvery scales. The proboscis, palpi, and antennæ, have blue and gold reflections. The pleura, or sides of the chest, are plated with flat gold scales with a pale lustre. The legs are dark brown, ornamented with scattered scales of silver and gold. While from the terminal segment of the body extends a miniature peacock's tail, termed the caudal fan; it is black with patches of gold. Thus, though our prejudices are strongly against the order, yet we cannot deny that this species possesses beauty.

One thing that strikes us is the shape of the proboscis. In most mosquitoes this organ is straight or slightly curved. This is an exception. The first half—a stout conical portion—projects straight from the head, but at the middle it bends abruptly downwards, tapering at the same time, like the lash of a whip.

An engineer, or a mechanic, examining that instrument would say that it was not meant for thrusting into flesh. It would be absurd to make a bayonet for a soldier with a curve in it like that. The hypodermic needle of

the surgeon must be made straight for its special purpose. If it were given a curvature, such as we have there, it would bend or break at the first thrust.

These considerations led me to dissect the organ with a good deal of interest, and I was rewarded by an interesting discovery, which, so far as I know, has not been noticed before. We are familiar with the statement that the female mosquito has neatly packed in her proboscis an armoury of six lancets. Some of these have minute teeth on their tips for deepening and enlarging the cut.

In the *Toxorynchites*, however, I found all the lancets, except two, much degenerated, seemingly comparatively useless for thrusting into flesh. Two, however, were well developed. One, the largest, is a hollow channel, open on its upper side, and bent to the curve of the proboscis, and represents the organ through which the blood is pumped in the biting species. The other was a long slender rod, which near its end expanded into a long club-like form, the swelling being covered with fine hairs, growing larger and curving outwardly as they approached the tip, so that you have a long curved channel, and lying in the inside a long handled brush, not very unlike, in miniature, to that long brush called a " turk's head," used by housewives in clearing cobwebs from the corners of a ceiling. This formation is quite unusual in the mosquito, and is analagous to some of the insects, whose chief food is the nectar of flowers and juices of fruit. The tongue of the honey bee is a ringed flexible organ, capable of considerable retraction and extension, and its food is lapped up in this way, the other mouth organs forming a tube up which the juices ascend by the action of the tongue. In the Mining Bee (which bores holes in the ground for the reception of its eggs), you have a tongue which is clothed with hairs in the same way as this mosquito.

The bee's tongue is not so long as this mosquitoe's proboscis, and the drooping shape certainly points to the idea that it is intended *not for piercing flesh*, but dipping into the nectaries of flowers and juices of fruits.

Another point of confirmation is that the flabella, or lips of the proboscis, are clothed on the inside also with fine hairs of a similar character, which by capillary attraction, would tend to suck up and retain floral juices, near

the tip of the channel of the larger lancet. In the head of the insect is found the pump, or aesophagial bulb, by which blood is drawn in other kinds of mosquitoes from their victims, but its size and muscular force might be insufficient to raise denser fluids, such as nectar, without the help of the hairy expansion on the end of the representative of the lancet. The probability is, therefore, this species, and most likely the group, are purely vegetable feeders, obtaining their food in *apis modo*, and are therefore harmless to man.

The cornea of the eye is of a denser structure than usual. The balteres are small in size, pale yellow; near the base on the anterior side, there is a triangular space filled with oval cells, united at their longer axis; above this, near the knob, is a stiff oval ring protecting a softer mass, which divides into two elongated lobes by a deep central fissure, the rim being bordered by minute hairs. These organs are richly supplied with nerves, and are doubtless organs of some special sense not yet understood. There are strong grounds for thinking that insects have senses differing widely from those possessed by man.

The terminal segment of the male body terminates in two slender hooks, and they are tipped by a straight moveable rod arising out of a shallow trench.

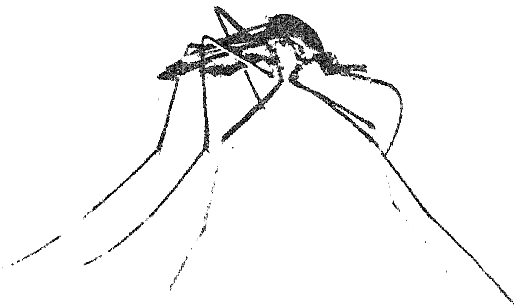
I take the following description of the male insect from Skuse:—Antennæ brown, a little more than half the length of the palpi; basal joint black, with horny reflections; second joint more than twice the length of the third, ornamented with some beautifully iridiscent scales, the whorl of very long hairs situated about one-third from the apex. Head covered with brilliant margaritaceous scales, chiefly reflecting green; in a certain light appearing brown, with a bright pale greenish line round the hinder border of the eyes. Proboscis somewhat longer than the palpi, deep metallic blue, with a purplish reflection before the bend, brown beyond. Palpi deep metallic blue, with purplish reflections, the third joint ringed with golden yellow at the apex, and the fourth joint with a broader ring of the same beyond the middle. Thorax brown, the lateral margins and prothorax densely covered with pale greenish scales, the latter with long brown hairs; hinder margin and scutellum richly adorned with brilliantly

iridescent scales, and long brown hairs; pleura with a naked brown stripe from the origin of the wings to the scale like prothoracic projection, below this densely covered with silvery scales; metanotum brown naked. Halteres, ochre yellow. Abdomen about twice the length of but narrower than the thorax, flat, deep metallic blue, except the first segment, the latter green with a yellow patch on each side; fifth segment shows some golden yellow laterally, sixth and eighth segments ornamented with a strong tuft of golden hair laterally, the seventh with black tufts; all the segments slightly bordered with golden hairs laterally; the first to the third and fifth to seventh golden yellow beneath with a metallic blue longitudinal stripe down the centre; fourth entirely metallic blue, and the terminal one brilliant pale green. Coxæ clothed with silvery scales. Femora and tibiæ metallic violet, the former golden yellow beneath. In the intermediate and fore legs, the first joint of the tarsi white except at the base, and the second also except at the apex; the rest metallic violet. Wings longer than the abdomen, with a pale brownish tint anteriorly and along the fifth longitudinal vein, veins pale brown, cilia pale and short, weak renections. Auxilliary vein joining the costa almost opposite, but somewhat beyond the posterior branch of the fifth longitudinal; sub-costal cross vein distinct, situated about midway between the origin of the anterior branch of the fifth longitudinal vein, and the origin of the second longitudinal; fork of the latter very small, the tips of the branches slightly bent anteriorly; supernumerary cross-vein equal in length to the middle cross vein; posterior cross-vein more than twice the length of the latter, rather sinuose, tip of the anterior branch of the fifth longitudinal vein joining the margin opposite the middle of the second posterior cell, a very prominent wing fold running close to the posterior side of the fifth longitudinal for the whole of its length, and another on the anterior side in the anal cell.

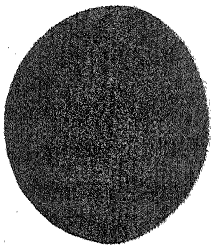
The question arises, as we are anxious to destroy the noxious kinds of mosquitoes, and there are unquestionably difficulties in the way, would it not be a wise thing to use this particular insect for that purpose? It is not the only mosquito possessing cannabilistic habits. There are two in our neighbourhood which in their larval state

are unmitigated cannibals. One of these is *Culex Tigripes* a number of these bred in a tub in the yard attached to my place of business last year. I have a slide here of one which has killed one of the yellow fever mosquitoes larva.

The Scotch Grey larva also kill all those within reach. But both of these are also blood suckers, so that they only kill to leave the ground clearer for their own depredations. But in the *Toxorychites* we believe we have a vegetarian, which does no harm to any human being, and is at the same time a deadly foe to the young of other kinds of the genus. It can be hired on very reasonable terms. Its working hours are not limited, and it is very unlikely ever to go on strike. It works in the very places where it is needed. All the specimens of larva I have seen have been got in old tanks about human habitations, just the working ground where it is of greatest use. So that we have in it an ally, which, if used, may be the means of greatly reducing the numbers of those which are not only a nuisance, but a danger to the health of the community. No attempt has ever been made in any country to use them for this purpose, so that Queensland might have the honour of leading the van in the contest.

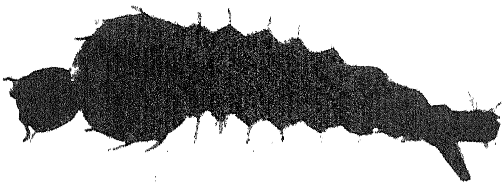


1.—Toxorynchites speciosa, × $3\frac{1}{2}$.



2.—Toxorynchites speciosa Egg, × 70.

3.—Toxorynchites speciosa, proboscis tip with brush lancet × 91.



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ANTHRACITE IN A FISSURE LODE.

By LIONEL C. BALL, B.E.

Read before the Royal Society of Queensland, 14th March, 1911.

INTRODUCTION.

IT is desirable that an almost unique geological occurrence—that of coal as gangue in a lead-zinc fissure lode, the discovery of which was among the more interesting results of my visit to the Mcnded Hill Mineral Field in June last—should be brought to your notice and so recorded. Economically the association of the coal and metallic ores is likely to be of some importance, for timber is very scarce in the district; and it may be possible, in milling and concentrating the ore, to save the coaly slime and use it in briquette form as fuel. Further, the certainty of there being a high class coal here should induce prospectors to be on the lookout for a workable seam in this part of the State; notwithstanding that if it is of inorganic origin, the possibility of which is shown below, no quantity of coal is likely to be discovered away from fissure formations.

STRATIGRAPHY.

The basal rocks of this field have generally been referred to the Silurian on the evidence of certain fossils from the Cairns Range, which lies 300 miles to the south. They consist of grits and shales seldom much altered except at the surface where they are silicified and bleached, but Dr. Jack,* who visited the field two and a half-years ago, discovered carbonaceous shales at the Lilydale mine, and the work done since his visit is indicative of similar, if not the same, shales occurring over an area of many square miles.

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*Report on the Lawn Hill Mines, Queensland. By R. Logan Jack, L.L.D., M.I.M.M., late Government Geologist. Sydney, 1908.

From a stratigraphical standpoint the indication that these supposedly Silurian strata are coal measures is of great interest; but unfortunately the carbonaceous shales rapidly disintegrate on exposure to the atmosphere, rendering search for fossils in the material of the waste dumps hopeless; and we are consequently without palaeontological assistance in correlating them with the sedimentaries outside of the district. Mr. Brown, the Government Geologist of South Australia, has, it may be mentioned, referred* the carbonaceous shales of the McArthur River, which may be an extension of the Queensland area, to the Permo-carboniferous system, on account of their resemblance to the productive coal measures on the north-western coast of the Northern Territory. Further field work in this quarter of Australia is thus likely to have very interesting results, and it may even yet be shown that the strata belong to some of the older palaeozoic formations, as Lower Silurian shales—black from diffused anthracite—are not unknown in other parts of the world.†

OCCURRENCE AND NATURE OF THE COAL.

The lodes of this field are in general composite fissure veins. The Silver King lode formation in particular has a width of over 60 ft., and, while looking into its capabilities as a lead and zinc producer, I noticed in many parts the gangue associated with crystalline blende and galena was very dark in colour. Specimens were collected and subsequently examined in the laboratory, where pyrognostic tests indicated the presence of carbonaceous matter, which it may be taken was probably effective in precipitating the sulphides of the ore body, although the average amount of fixed carbon over the whole width of the formation does not exceed 1 or 2 units per cent. Some of the less crushed matrix having the physical characters of coal, a fragment was handed to the Government Analyst, who found it (when separated from the attached ore) to have the composition tabulated below. This result agrees fairly well with the partial analysis of an ordinary commercial anthracite,‡ though the volatile matter is rather lower

*Geological Reconnaissance from Van Diemen's Gulf to the McArthur River, 1907.

†See Geikie's Text Book of Geology, 3rd Edition, p. 145.

‡See Economic Geology, Vol. 4, p. 657.

than in Welsh anthracite and yet at the same time considerably above that of anthraxolite as shown in the subjoined tables :—

Constituent.	Burketown, M. F.	Anthracite.*	Anthraxolite.†
i. Analytical Result (at 100° C.).			
Moisture	1·5%	——	4·0%
Volatile Matter ..	3·1%	5·80%	1·8%
Fixed Carbon	85·9%	92·64%	90·1%
Ash	9·5%	1·56%	4·1%
ii. Recalculated composition of water—and ash—free coal.			
Volatile Matter	3·5%	5·9%	1·9%
Fixed Carbon	96·5%	94·1%	98·1%

ORIGIN OF THE COAL.

It seemed at first that the question of orgin would not be difficult to settle and that the coal, during movements of the wall rock, must have been dragged into the formation from a bed traversed by the fissure, the carbonaceous character of some of the country rocks lending support to this view; but subsequent study of the available literature of the subject has convinced me that the evidence is not altogether conclusive, and that there is a possibility of the hydrogen and carbon having been derived from a deep-seated magmatic source. That is to say that the coal has been produced like the Canadian anthraxolite (the proximate analysis of which does not differ greatly from the above) from bitumen or petroleum, the case for the magmatic origin of which, long urged by French and Russian geologists and chemists, has been very ably stated by Mr. Eugene Coste, of Toronto.‡ Even if it is allowed that some petroleums may be of organic derivation the inorganic origin of others seems almost certain.

* Analyses of British Coals and Coke, p, 369.

† Ann. Report Bureau of Mines, Ont., 1896, p. 159.

‡ See Journal of the Canadian Mining Institute, Vol. 12, p. 274.

APPENDIX I.

Parallel Cases.

It may be as well to here refer to the few other cases known to me of coal accompanying metallic sulphides in fissure lodes.

Germany.

Ulrich has stated* that mineral coal occurs in ore lodes in several mining districts in Germany, but I have been unable to discover his original authority.

United States.

The association of coal with lead and zinc sulphides has been noted† in Missouri, but, from the brief descriptions written, it would seem that the ores there occur not in lodes but in coal seams; and that the metals were precipitated by the carbonaceous matter from percolating meteoric waters.

Canada.

A carbonaceous material similar to non-caking bituminous coal has been said‡ to occur in a mica vein in Quebec, but confirmation of this is needed.

Tasmania.

Anthracite has been reported from several mines in Tasmania. Mr. W. F. Petterd quoted§ Ulrich in reference to an occurrence of anthracite "in irregular veins up to ¼-inch in size enclosed in calcite and siderite in the abandoned lead mine North Valley, Mt. Bischoff."

In the same work Mr. F. Danvers Power is credited with having identified anthracite "in the workings of various quartz reefs in the Beaconsfield Goldfield," but the substance had already been determined|| by Messrs. A. Montgomery, the then Government Geologist, and W. F. Ward, the Government Analyst, to be a variety of lignite,

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*See Catalogue of the Minerals of Tasmania. By W. F. Petterd. Hobart. By Auth., 1910, p. 51.

†Lead and Zinc Deposits of Missouri. By Arthur Winslow and J. D. Robertson, 1894, p. 157.

‡ J. Can., M.I., Vol. 7, p. 245.

§ Op. cit. (8).

|| See Aus. Ass. Adv. of Sci., Vol. 4 (18).

being brownish black in hue and having the following composition :—

C. 38·91 ; H., 3·03 ; O. and N., 21·60 ; S., 2·36 ; Ash, 12·00 ; Moisture (at 100° C.), 22·10%=100.

They show that it is mostly found in sandy layers between hard beds of grit (of Silurian age) and also penetrating into cracks and joints in thé beds where much shattered. Some years later Mr. Twelvetrees, the present Government Geologist, found on the 800 ft. level in the Moonlight-cum-Wonder mine, lying between grits and limestone, " a peculiar brown earthy carbonaceous (compact bedded) deposit (nine feet wide on one side of the drive) approaching in character to semilignite or brown coal," of which the following proximate analysis is given :—

Moisture (loss at 212° F.)	38.1%
Gases, &c. (lost at red heat)	27.0%
Fixed Carbon	13.9%
Mineral Matter (ash)	21.0%
	100.0%

To account for the origin of the lignite Messrs. Montgomery and Ward suggested that it had been deposited from percolating swamp waters, that with the organic matter in suspension descended in quite recent geological times from the surface wherever the much shattered strata offered a ready passage. I do not suppose that when they wrote their paper the possibility of the magmatic origin of hydrocarbons had been seriously considered outside of Europe, but the theory has now many staunch supporters in all parts of the world and would seem to fit this case perfectly. The reference* of Mr. W. H. Twelvetrees to recent timber among boulders of conglomerate, 370 ft. beneath the surface in the Eureka Claim, points to former open communication with the surface at that place, but it need not have any bearing on the origin of the lignites.

APPENDIX II.

Solid Hydrocarbons in Fissures.

That various solid hydrocarbons and carbo-hydrates fill extensive fissures is well known. Such are those of asphalt in Utah, Cuba† and Peru,‡ of albertite in

* See Report on the Moonlight-cum-Wonder Mine at Beaconsfield, Launceston. By Authority, 1902.

† Economic Geology, Vol. 1, p. 437.

‡ Transactions of the American Institute of Mining Engineers Bulletin, No. 27, p. 291.

Nova Scotia, and of grahamite in Western Virginia. Their associations with metalliferous minerals is much rarer, but Dana records* elaterite (with lead ore and calcite) from the Odin lead mine in Derbyshire, resin (with calcite and pearlspar) from the Settling Stones lead mine in Northumberland, and idrialite (mixed with cinnibar, clay, pyrite and gypsum, in brown-black earthy material) from the Idrian mercury mines, Austria; and certain of the asphalite veins of Peru include lenses of sulphides and are mined for vanadium.†

APPENDIX III.

GRAPHITE.

Graphite is believed to be in certain cases an end product in the destructive distillation of petroleum that has risen from below.‡ Besides occurring disseminated in some of the older rocks of the earth's crust it is known in fissure veins in Quebec (in gneiss), Ceylon (in granite rock), Cumberland (in greenstone porphyry) and Siberia (in granite and limestone).§

Associated with iron ores it is found at a number of localities; but Cirkel, the Canadian authority, mentions only one occurrence with gold (in quartz at the Sunnyside Extension mine, San Juan), although it occurs in several silver veins in Ontario,‖ including the Silver Islet, La Rose and Cobalt Hill). Liversidge mentions $ its occurrence with quartz, iron pyrites, and pyromorphite at the head of the Abercrombie River.

In our own State, Mr. Dunstan has shown¶ that the granites of Croydon are graphitic and contain iron pyrites, copper pyrites, galena and arsenical pyrites in small quantities, and though he does not actually affirm it, the carbon appears to have been the precipitating agent.

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* System of Mineralogy.

† Op. cit. (15).

‡ See Geikie's Text Book of Geology, 4th Edition, p. 186.

§ Graphite. By Fritz Cirkel, Dept. of Mines, Canada, 1907.

‖ J. Can., M.I., Vol. 10, p. 55.

$ Minerals of New South Wales. London, 1888.

¶ G.S.Q. Pub., Nos. 202 and 212.

APPENDIX IV.

Gaseous Hydrocarbons in Metalliferous Mines.

Some passing mention should be made of the occurrence—unusual but by no means non-existent—of gaseous hydrocarbons in metalliferous mines; but time has not permitted of my looking up the bibliography of the subject and I can refer to but one case, that of the Silver Islet mine, Ontario, in which gases were met at 1,000 ft. beneath the surface. This was mentioned in a discussion* on the ore deposits of the Cobalt district, when a member, Mr. Hixon, suggested the possibility of the hydrocarbons being magmatic and incidentally the cause of the silver of the lodes being in the metallic state.

*Op. cit. (20)

NOTES ON THE GEOLOGICAL AGE OF VOLCANIC ACTIVITY IN SOUTH-EAST QUEENSLAND.

By E. O. MARKS, B.A., B.E.

Read before the Royal Society of Queensland, 24th June, 1911.

THE following notes have been compiled in the desire of interesting members of this Society in a question on which, in the past as well as in the present, very divergent views have been held—namely, the question of the geological ages of volcanic activity in this corner of Queensland.

A problem of this nature is always, to a geologist, one of exceptional interest; in this case, affecting as it does extensive areas of coal measures, it is one which in the future will possibly possess considerable economic importance in addition to its scientific interest.

A by no means small attraction is added by the fact that to the varied volcanic rocks are due, entirely or in part, so many of the physical features characterising the landscapes with which we are familiar, such, for instance, as the Glass House Mountains, the rugged scenery of Mt. Barney and its neighbours, or of Cunningham's Gap, the broad rich valleys of the Darling Downs and the beauties of the Toowoomba Range, or the richly beautiful scrubclad valleys, gorges and lofty plateaux which render the head-waters of the Logan, Albert, Coomera and Nerang rivers, a region destined to become the pleasure resort of our metropolis.

Volcanic rocks attain a very considerable development in the south-eastern corner of this State, and consist of widely varying types. The petrological characteristics of many of the rocks have received a good deal of attention, chiefly from Dr. H. J. Jensen, and further study in this direction is much to be desired. It is not intended here,

however, to discuss the petrology, except in so far as it concerns the determination of the geological age.

The rocks may be divided for field purposes into the two main types, trachytic and basaltic, though each of these contain widely differing rocks. Many of them have been determined by Dr. Jensen to belong to the alkaline types. Both tuffs, lavas and dykes are met with.

All Brisbane residents are familiar with the trachytic tuff, or so-called "porphyry," on the streets and in buildings, as well as with the rock in situ in Kangaroo Point, Leichhardt Street, and other places in and near the city. Trachytic rocks also occur in or form the Glass House Mountains and other mountains in East Moreton, Flinders Peak, Mts. Lindsay and Barney, Cunningham's Gap, the Little Liverpool Range, and near Esk, besides many other localities known, and many, probably, not yet recorded.

Rocks of the basaltic type are even more extensively developed, occupying, as they do, so much larger an area than the more acid lavas, due probably to their more mobile condition when extruded. They partake in the formation of the Blackall Range, Tambourine Mt., portions of the Macpherson Range, Little Liverpool and Main Range, as well as large part of the Darling Downs. They are found besides at lesser elevations, and in the neighbourhood of Brisbane and Ipswich, from such comparatively low-lying areas as Cooper's Plains, Manly, Redbank Plains, Bundamba, etc.

The first observer to offer an opinion as to the ages of the volcanic rocks was the late Sir A. C. Gregory, who, in his capacity of Geological Surveyor for Southern Queensland, between the years 1875 and 1879, traversed much of the country in which they occur. In his report on the south-eastern districts of the Colony of Queensland, he says that the basaltic rock "may be referred to a very recent date in the Tertiary era." He refers, both in this report and in one on the coal deposits of West Moreton and Darling Downs, to the fact that at Clifton coal mine, under 30ft. of basalt, large pieces of fossil wood were found so little altered that it split and warped several inches on being exposed to the air. It was associated with woody seed vessels (*Conchotheca Turgida*). The latter were referred for determination to Baron von Mueller, who

mentions their having been obtained beneath basalt—a record to which the writer's attention was kindly drawn by Mr. E. C. Andrews.

In describing the "porphyritic" rocks, Sir A. C. Gregory considered them to be older than the basaltic, which have cut through and overlie them. He also considered them to be later than the "carbonaceous series," which had not then been classed as of Trias-Jura age, but included with them the Brisbane rock.

In 1887 and 1889, Mr. W. H. Rands, working in Brisbane and in the Logan and Albert districts, determined the Brisbane "porphyry" to be a trachytic tuff, lying at the base in this locality at any rate, of the Trias-Jura system. He encountered at Walton (now Woodhill), a trachyte which he considered to be contemporaneous with the coal measures in which it occurs. The basalt of Tambourine Mt. and the Macpherson Range, found both on the Trias-Jura beds, and on the underlying schists. Mr. Rands considered to be later than the coal measures and Woodhill trachyte, but older than the desert sandstone (Upper Cretaceous), to which age he ascribed a sandstone resting on the basalt and containing pebbles thereof, at the head of Nerang River.

Dr. Jack, in his Geology of Queensland, pointed out that it is a mistake to suppose that the volcanic rocks consist of only one continuous series, but expressed the opinion that the basalt of Tambourine is not necessarily of later age than the Woodhill trachyte, since it lies on strata considerably lower in the Trias-Jura system than the horizon at Woodhill. Dr. Jack considered that the basalt of the Toowoomba Range is contemporaneous, though locally uncomformable with the Trias-Jura rocks, beneath the upper portion of which he supposed them to dip to the west, thus accounting for the absence of an escarpment in that direction to correspond with that forming the Main Range. The basalt at Ipswich he also thought to be contemporaneous with the coal measures there, but this has since been shown of more recent origin. The basalt of Clifton and elsewhere appearing to occupy local hollows in the stratified rocks, he himself considered to be later age than the Trias-Jura.

Mr. S. B. J. Skertchly, in a report on the geology of the country round Stanthorpe and Warwick, refers to the basalt of the Toowoomba Range as Tertiary, but does not record the sections which lead him to that conclusion.

Dr. H. J. Jensen has made several important contributions to the study of South-East Queensland igneous rocks, chiefly in papers read before the Linnean Society of N.S.W. The rocks described are in the East Moreton as well as in the Fassifern districts, and he refers all of the volcanic rocks he found on Trias-Jura areas to a post-Trias-Jura age. He records, in the Fassifern district, trachyte dykes in the Trias-Jura sandstone, a basalt injected in and overlying the trachyte, but gives no actual section proving, in our present ignorance as to the horizon occupied by the sandstones intruded, that the volcanic rocks are post Trias-Jura.

Mr. E. C. Andrews, of the New South Wales Geological Survey, in working near the Queensland border, referred the trachytes and basalts of the Macpherson Range to the Trias-Jura age, but subsequent work has, the writer understands, led him to regard them as of Tertiary age, corresponding presumably with the undoubted Tertiary basalts of New England, described by Prof. David, as well as by himself.

The present writer, in examining the coal measures south of Brisbane, came to the conclusion that the volcanic rocks met with—almost entirely of the basaltic type—belong to two ages, Trias-Jura, and late or post-tertiary. Several sections were observed, including Mr. Rand's Woodhill trachyte, of interbedded volcanic rocks amongst the upper or Walloon coal measures, in the neighbourhood of Beaudesert. These occurrences, however, are possibly merely sills or dykes parallel to the bedding, though an examination of them does not give one that impression. In a flying visit to the coal seams outcropping in the Upper Logan district, a site was pointed out by Mr. J. Buchanan, where an outcrop of carbonaceous shale or weathered coal had been covered by a recent slip in the bank of Christmas Creek. Mr. Buchanan remarked on the outcrop having been perpendicular, and the writer observed that sandstone in juxtaposition with the fallen ground was also perpendicular, and that this sandstone contained rounded pebbles of basalt similar microscopically to the andestic basalt

of the neighbourhood. Some distance further down the creek, a similar sandstone is seen resting on basalt. Owing to circumstances, a detailed examination could not then be made, but the section thoroughly convinced the writer of the Trias-Jura age of the basalt in that locality. The absence of detailed examination or of fossil evidence regarding the sandstone and carbonaceous beds forms but a slight flaw in the otherwise absolute proof, since undoubted Trias-Jura strata occur, with coal seams, on Widgee Creek, less than two miles away, and the same formation appears to extend throughout the intervening ground. The vertical position of the strata, moreover, does not accord with the comparatively undisturbed character of the Tertiary formations elsewhere.

The sandstone and included basalt is presumably on the same horizon as that observed by Mr. Rands, and ascribed by him to the Desert sandstone. Since the time of Mr. Rand's observations several areas which had been attributed to the Desert sandstone on physical grounds—the only data available—have since proved to be of greater age. It is more than probable, there being no evidence to the contrary, that the sandstone observed by Mr. Rands is of Trias-Jura age, like the remainder of the sandstone in its neighbourhood.

A paper on the Volcanic Eruptives of West Moreton, by R. A. Wearne and W. G. Woolnough, to the former of whom the field work was due, was read before the Sydney meeting of the Australasian Association for the Advancement of Science in January this year, but has not yet been published. The authors consider that there are, in all probability, two volcanic series :—

(1) Of Trias-Jura age, contemporaneous with the Walloon stage of the Trias-Jura ;

(2) Of Tertiary age.

The former of these includes the normal trachytes, andesites and basalts of the Main Range ; the latter includes the more alkaline trachytes (comendite and grorundite) of Mt. French, Mt. Greville, etc., the rhyolites of Mts. Maroon and Barney, and the basalts of the Toowoomba Range.

Proof of the Trias-Jura series lay in the discovery of—

(1) Trachyte tuff containing *Taeniopteris Daintreei*, found in the Lockyer district, near the Main Dividing Range (near Mt. Mistake) ;

(2) A number of trachyte pebbles found in conglomerate in the upper portion of the Walloon coal measures, in the Fassifern and Lockyer districts.

The authors thus ascribe the trachytic as well as basaltic rocks to two distinct ages. The Toowoomba basalt, an olivine basalt, is considered to be Tertiary, being distinct petrologically from the basalt referred to as Trias-Jura age, which appears to be of a similar character to that of the Upper Logan districts.

It is interesting to note that the numerous areas of basaltic lava which occur in the neighbourhood of Brisbane, still occupying in places the valleys in which it originally flowed, and nowhere attaining any noteworthy elevation, consist of an ophitic dolerite varying very slightly in character in any of the localities from which the writer has examined specimens. This rock, which is of undoubted Tertiary or post-Tertiary age, is equally distinct petrologically from either the Toowoomba basalt or the andesitic basalt of the Macpherson Range.

This dolerite is familiar to us as the "blue metal" of the streets, for which purpose its great toughness is somewhat discounted by its defective binding power—a defect due to its fine and uniform texture. At Redbank Plains, Cooper's Plains and Runcorn, and probably elsewhere, this rock lies on strata, bearing, in certain localities, a plentiful dicotyledonous flora as well as fish and reptilian remains, the age of which have not yet been definitely determined.

From the foregoing list of observations and opinions, we may summarise the present state of our knowledge of the ages of vulcanicity as follows:—

Undoubted post Trias-Jura basaltic rocks occur near Brisbane, and at Clifton, on the Darling Downs. These rocks are probably of late Tertiary if not of post-Tertiary age.

From opinions formed in the field, though not supported up to the present by any positive proof, several observers are persuaded also of the post-Trias-Jura age of some (or most) of the trachytic rocks, a diversity of opinion existing as to whether the main body of these are Trias-Jura or post-Trias-Jura. There can be no reasonable

doubt that some are Trias-Jura, excluding the Brisbane tuff, the age of which has long been beyond question.

There is little if any room for doubt also as to the Trias-Jura age of much of the basaltic rock, more especially in the eastern portion of the Macpherson Range.

Opinion is divided in regard to the Toowoomba basalt, no definite proof having been recorded up to the present in favour of either view.

Intimately associated as the volcanic rocks are with the Trias-Jura system, it is essential to realise how much or how little we know about that system before we refer rocks to any particular stage of it. Up to the present time, the only connected or in any way detailed examination made covers a comparatively small area in the neighbourhood of Ipswich and Brisbane, and from there south to Beaudesert—a total area of roughly some 1,000 square miles of the strata. The whole formation covers at least 15,000 square miles, so our knowledge must be regarded as very incomplete. Inside our limited area we are aware of three divisions—in ascending order:—The Ipswich coal measures, the Bundamba sandstones, and the Walloon coal measures. We are, however, in no way justified in supposing that the Walloon coal measures form the summit of the formation, just as the Ipswich coal measures are not necessarily the lowest division, though certainly so locally.

In the greater part of the areas in which the volcanic rocks occur, the sedimentaries have been the subject of only few and disconnected observations, and it is highly desirable to realise that, in the absence of connected and reasonably detailed work, we are practically in complete ignorance as to the stratigraphical position of these sedimentaries in the Trias-Jura system. For instance, it is a pure assumption, but one that is often made, that the coal measures of the Darling Downs are on the same horizon as those of Walloon. Except for a certain similarity in their coals, there is really not the slightest reason in our present knowledge to suppose this to be the case, though there is every likelihood of it being so.

The basalt of Tambourine Mountain is similar to, and, except for denudation, continuous with that of the Macpherson Range, which is almost certainly of Trias-

Jura age. Yet the Tambourine rock rests uncomfortably on beds low in the system, as well as on the underlying schist.

The unconformability is interesting, for it shows elevation during Trias-Jura times; it also serves to accentuate the fact that the mere superposition of lava on portion of the system is no evidence, the horizon being unknown, that the lava is of post Trias-Jura age.

Should contemporaneous volcanic rocks prove of wide extension, their study is likely to be of great assistance to the stratigraphy of a system, that otherwise appears to offer few sharply-defined limits on which to base the divisions. The study may thus be of no small aid in the intelligent prospecting of the coal measures.

In those districts where volcanic rocks of both ages occur, or where the age has not been definitely determined, it will be necessary to preserve an entirely open mind regarding the age of any particular rock met with, remembering always that neither the contemporaneous nor the later rocks necessarily belong to only one brief period of vulcanicity. We know that elsewhere in Australia there were two periods of volcanic activity in Tertiary times, and it is not unlikely that representatives of both these occur in our area.

Volcanic materials, chiefly tuffs of no considerable development, occur in Mesozoic rocks elsewhere in Australia, but volcanic activity is considered to have been the exception, in Mesozoic times, throughout the world, a fact conferring greater interest on such rocks as do belong to that period. Where, as seems likely in this present case, the volcanic activity was extensive, the interest is considerably increased.

It is hoped that these few notes, in drawing the attention of members of this Society to the question will help towards its study by reducing the greatest difficulty—the lack of observers where so much is to be observed.

BIBLIOGRAPHY.

Andrews, E. C.—

An Outline of the Tertiary History of New England.

A Preliminary Note on the Structure of Mt. Lindsay. Records Geol. Surv., N.S.W., Vol. VII., Part III.

David, T. W. E. —

Presidential Address, Section C., Australasian Association for the Advancement of Science, Hobart, 1892.

Contribution to the Study of Volcanic Action in Eastern Australia. A.A.A.S., 1893.

Vegetable Creek Tin Mining Field.
Memoirs, Geol. Surv., N.S.W., Geology No. I.

Gregory, A. C.—

Coal Deposits of West Moreton and Darling Downs Districts, 1876. (Council and Assembly Paper).

Geological Features of the South Eastern Districts of the Colony of Queensland, 1879. (Legislative Assembly Paper).

Jack, R. L.—

Geology and Palaeontology of Queensland and New Guinea (Jack and Etheridge), 1892.

Jensen, H. J.—

Geology of Glass House Mountains.
Proceedings, Linnean Society of New South Wales, 1906.

Geology of the Volcanic Area of the East Moreton and Wide Bay Districts.
Proc. Linn. Soc., N.S.W., 1906.

Distribution, Origin and Relationships of Alkaline Rocks.
Proc. Linn. Soc., N.S.W., 1908.

Geology of Mt. Flinders and the Fassifern District.
Proc. Linn. Soc., N.S.W., 1909.

The Alkaline Rocks of Southern Queensland.
A.A.A.S., Brisbane, 1909.

Marks, E. O.—

Coal Measures of South-East Moreton.
Geol. Surv., Q. Publication, No. 225.

Rands, W. H.—

Geological Map of the City of Brisbane and its Environs, accompanied by a Report.
Geol. Surv., Q. Publication, No. 34.

Geology of and Minerals occurring in the Neighbourhood of Beenleigh, and of the Logan and Albert Rivers, 1887.
Geol. Surv., Q. Publication, No. 36.

Rands, W. H.—
The Albert and Logan Districts, 1889.
Geol. Surv., Q. Publication, No. 51.

Skertchly, S. B. J.—
Geology of the Country Round Stanthorpe and Warwick.
Geol. Surv., Q. Publication, No. 120.

THE BUILDING OF EASTERN AUSTRALIA.

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Read before the Royal Society of Queensland, July 29th, 1911.

I. INTRODUCTION.

SCOPE OF PAPER.

THE object of this paper is not to offer the reader any really new material, but rather to present the knowledge we already possess in a concise form, and to point out which of the very many more or less conflicting theories of earth mechanics are most capable of explaining the facts observed in Australia.

The books and papers referred to in the compilation of these notes are so numerous that they are separately entered up in Appendix I. The maps illustrating the growth of Eastern Australia in geological time are based on those issued by Professor David to his tectonic geology class.

It shall be my endeavour first of all to show how the geography of Australia has changed during geological time. After these changes have been described we will try to enquire what meaning can be assigned to them, and what kind of earth movements produced them. We will then further discuss the structural unity of Eastern Australia. The Petrological Unity of Eastern Australia will then be discussed and at the same time some remarks will be made on the origin of some leading Australian ore deposits.

We shall then pass on to the treatment of faulting and folding, the causes of these movements and their effects on topography. The origin of some of our most important land forms and scenery will then be briefly dealt with.

THE RECONSTRUCTION OF PALÆOGEOGRAPHY.

Just as the historian and the antiquarian in their discussions on events prior to the exact historical period speak of the stone age, the bronze age, and so forth, dividing early historical time according to the nature of the debris characterising the age, so the geologist, who has no exact conception of the duration of his periods, divides geological time into the age of fishes, the age of reptiles, the age of Brachiopods, and so forth.

Just as the historian divides time into periods and his periods into dynasties, so the geologist divides his geological time into periods, and his periods into epochs. In the same way as the historian speaks of the Heroic Age or Era, so the geologist speaks of the Palæozoic Age or Era. The historian has his shepherd king period, Plantagenet period, and so on; the geologist, likewise, has his Devonian Period, Miocene period, and so on. Just as the historian speaks of the dynasty of the Ptolemys, Hanover dynasty, &c., so the geologist has geological horizons based on the predominance of some particular dynasty of animal or plant life.

Our knowledge of the geography of past geological ages is gathered from the study of the fossilised remains of plants and animals. Of all petrifactions, none are so important to the geologist as shallow water marine organisms; because of their abundance in the fossil state, and their uninterrupted sway during the long ages they afford us landmarks, not only for the division of geological time into periods, but also into horizons and stages. The long persistency of each genus allowed it to differentiate into sub-genera and species, which, besides being very absorbing studies for the evolutionist, are also of great value in delimiting the minor divisions of geological time.

In the following pages it is taken as an axiom that a great accumulation in any place of marine fossils indicates close proximity to the shore line at the time of deposition. This follows from two considerations. In the first place the waters of the continental shelf are better adapted, both as regards temperature and food supplies, for plant and animal life. In the second place, the opportunities for organisms to be preserved

are better near the shore where sediments may bury them, and where the high pressure of deeper levels does not exist and exert great solvent power on the objects deposited. It is, therefore, axiomatic that the greatest thickness of sediments and the greatest profusion of fossil remains occur within 150 miles of the coast.

The nature and distribution of sediments of various ages, therefore, gives us a clue as to the position of the shorelines of these ages. A glance at the maps on the following pages should convince anyone that prior to the Tertiary period, Australia had a much different outline from that of to-day, and that the geographical unity of Australia begins with the Tertiary. [1]

II. PALÆOGEOGRAPHIC STUDIES.

(A) PRE-CAMBRIAN.

By referring to the map (*Fig.* 1) we see that the known Pre-Cambrian areas of Australia are all grouped in the western portions of the continent and Tasmania. A curve drawn from the north-east corner of Tasmania to the Kimberley district of West Australia, with a slight convexity to the north-east embraces all the best known Pre-Cambrian areas of Australia. Such a curve, it is interesting to note, would have its centre near Kerguelen Island, in the Southern Ocean. But, as the Pre-Cambrian is a geological scrap-heap for all the formations which antedate the appearance of life on the earth, rocks of that age must underlie all later formations, and they cannot be utilised in the reconstruction of Pre-Cambrian geography. All that we can say is that both sea and land were in existence in this great epoch, for the Pre-Cambrian rocks are largely of sedimentary origin.

The principal Pre-Cambrian areas of Australia are (1) the West Tasmanian area; (2) Yorke's Peninsula, West of Adelaide; (3) the Musgrave Ranges and part of the Victoria Desert, South Australia; (4) an area near Broken Hill; (5) the Macdonnell Ranges, South Australia; (6) the Kimberley Area, West Australia, and (7) the Coolgardie and Kalgoorlie areas, W.A. The igneous rocks of this early period comprise both acid and basic varieties. The acid rocks consisted of granites,

felsites, graphic granites, gneiss, augen gneiss, basalt, andesite and gabbro.

The sedimentary rocks comprise quartzites, mica schists, andalusite schists, marbles and limestones.

The western portions of Australia, which are so largely of Pre-Cambrian age, have probably in the main, escaped heavy sedimentation in all subsequent geological periods, for otherwise a heavy coat of later sediments would frequently hide the Pre-Cambrian rocks. Western Australia was, therefore, uplifted at an early period. It formed part of a Pre-Cambrian landmass which extended in a north-west direction to Arabia and Abyssinia and south-wards to Antarctica. This great landmass was probably fairly persistent throughout Palæozoic times, since Africa, India and Australia had a similar flora up to the end of the Palæozoic, namely the Lepidodendron flora of the Carboniferous and the Glossopteris flora of the Permo-Carboniferous.

The absence of sediments newer than Pre-Cambrian over large areas of Western Australia, is not the sole evidence for supposing this area to have been essentially a continental mass from that remote geological age to the present. A strip of the west coast of W.A. was subjected to several marine transgressions in late Palæozoic and Mesozoic times, but sedimentation was neither prolonged nor heavy, for practically all deposits later than Pre-Cambrian are almost undisturbed by any compressional forces, their dip seldom exceeding 20°. The sediments of various later geogolical ages are deposited upon highly folded, inclined and contorted rocks, consisting of schists, conglomerates, gneisses and igneous rocks of the Pre-Cambrian complex. Even the Cambrian rocks, such as the Nullagine series of Pilbarra, are little disturbed. The Nullagine, Carboniferous, Permian and Mesozoic rocks, where in juxtaposition, are not easily separable by such criteria as hardness, metamorphism, difference in angle of dip, and so forth, but mainly by the occurrence of unconformities between them. Consequently the transgressions of the ocean in these periods did not interfere with the geological unity or plateau character of Western Australia.

Another point of interest in this connection is the fact that artesian water, which occurs in Queensland only in rocks of late Mesozoic age, has been obtained in Western Australia in rocks of Permian, Carboniferous, and even older ages. This shows still more forcibly that since the early Palæozoic, Western Australia has been a unit or block of the earth's crust in which no compression of strata has occurred, and in which the only earth movements (faults and fractures) have been the result of tangential strain.

In Bull. 33, Geol. Surv. of W.A., Mr. A. Gibb-Maitland [2] shows that at Pelican Hill artesian water was obtained at a depth of about 3,000 feet in the lowest bed of the Carboniferous series, a sandstone stratum about 448 feet thick. In the Collie Coalfield mining is greatly handicapped by the constant soakage of artesian water into the workings.

In the Irwin Coalfield (Bull. 38, Geol. Surv. of W.A.), the coal is hydrous, and the carboniferous rocks are water bearing. [3]

Clearly, from this the post-Cambrian rocks of the Western Australian block are porous by virtue of being uncompressed, and in many cases they are in a state of strain or tension. We may therefore conclude that West Australia has been a relatively rising mass from the beginning of the Cambrian.

In Eastern Australia, all rocks of pre-Triassic age have undergone such compression that their original water content has been expelled, and they have become too impervious to take up water again.

Cambrian Sedimentation.

Examination of the Cambrian areas of sedimentation shows (*Fig.* 2) us that they are all situated to the east of the main Pre-Cambrian massive, already referred to. They lie on a definite band about 300 miles wide, running in a crude north-westerly direction from Tasmania to Kimberley, in W.A. This band then corresponds to the Cambrian area of intense sedimentation, including the continental shelf of the period.

The chief localities for Cambrian rocks are the Caroline Creek district in Tasmania; the Heathcote

district, Victoria; the Mt. Lofty Range, north of Petersburg, Kangaroo Island, Vincent's Gulf, and thence north to the Queensland border, in South Australia; and the Kimberley district in Western Australia. These beds are in many places rich in the forms of life characteristic of the period—such as the coral Archæocyathinæ; sponge spicules; the trilobites Conocephalites, Microdiscus, Olenellus, Dikellocephalus; the pteropods Salterella and Tentaculites, and the Gastropod Ophileta.

While the belt referred to was probably the continental shelf and region of heavy sedimentation in Cambrian times, it is probable that the Cambrian ocean extended eastwards over the whole of Eastern Australia. The remarkable crystalline and wholly unfossiliferous rocks, which are known to us as the Brisbane Schists, the Byron Bay Schists and Coff's Harbour Schists, are probably deep sea deposits of Palæozoic age, which accumulated in the profound and lifeless ocean during the periods ranging from Cambrian to Devonian. At great depths life would be scarce, and any remains of skeletons of organisms which may have dropped to the bottom would speedily go into solution.

During the Lower Cambrian period, a glacial age was experienced in Australia, boulder beds of iceworn nature outcropping in many places on the belt of Cambrian sediments, right from Adelaide north to the Queensland-South Australian border, and in the north of Western Australia. [4]

Ordovician Sedimentation.

The region of the heaviest Ordovician Sedimentation lies east of the region of heaviest Cambrian deposition. The latter had been uplifted and largely converted into dry land before the Ordovician period. The continent had therefore taken a step in the direction of the rising sun. A strip, two or three hundred miles wide, lying east of the Cambrian continent, had been converted into land. (*Fig.* 3).

The Ordovician in the Australian region was truly an age of graptolites, which were in many parts, particularly in Victoria, buried in such numbers as to give a graphitic character to the shales and slates of this period. These graphitic shales have acted as precipitants for gold,

so that they stand in the same relation to the goldbearing quartz reefs of Victoria as the plumbago beds of the Gympie Goldfield stand to the reefs there.

The main areas of Ordovician Sedimentation in Australia were the Cephalopodan limestone of Tasmania, the Victorian graphitic shales at Sandhurst, etc., the black graptolite slates of the Victorian and Snowy Alps, the Myall Reefs, N.S.W., the graptolite slates at Dubbo and Cadia (near Orange), N.S.W., the Mandurama graptolite and radiolarian rocks (N.S.W.), and the Larapintine system of the MacDonald Ranges of S.A.

The Ordovician rocks of N. S. Wales, Victoria and Tasmania were probably deposited in very deep water, radiolaria being very abundant in them in the Snowy Alps, at Mandurama and elsewhere.

Contemporaneous tuffs and lavas were erupted and occur in the series at Mandurama and Cadia, N.S.W. These volcanic extrusions were of an andesitic nature.

Silurian Sedimentation.

Silurian sediments occur over wide areas of Eastern Australia. In Victoria, Tasmania and Southern N. S. Wales, where the Ordovician sea was deep, the Silurian sediments follow the Ordovician, and largely overlie them. Further north, however, the areas of most intense Silurian sedimentation are several hundred miles east of the main Ordovician belt. (*Fig.* 4).

The Silurian Sea was an extensive one, and a moderately shallow one. Corals played an important part in the life of the time.

Silurian rocks occur at Yass and Bowning, the Jenolan Caves, Wellington, Molong, etc., in N. S. Wales; at Chillagoe in Queensland; at Lilydale in Victoria, etc.; and at Yass (N.S.W.) they contain banded rhyolites and tuffs of a dacitic nature, and submarine tuffs at Wellington (N.S.W.)

The shallow nature of the Silurian Sea, together with the slow uplift of the sea bottom, caused a rapid advance of the coastline towards the east, so that it is doubtful that the various Silurian areas of Australia are contemporaneous. They are homotaxial, and belong to the same great period—but may have become elevated into dry land at different times in that period.

Most of the important cave-limestones of Australia belong to the Silurian—as for example, those of Chillagoe and Mungana in North Queensland, and those of Jenolan, Wellington and Yarang-obilly in New South Wales. The rugose and tabulate corals of that age apparently did not build on a subsiding sea-floor as the madrepore and millepore fauna of the Pacific to-day, but were building on a slowly rising seabottom, gradually extending their domain as successive portions of the ocean floor were raised to the zone of shallow water.

THE DEVONIAN.

In the Devonian Period, the ocean which in the early Palæozoic covered Eastern Australia was much reduced. Here and there basins remained in which Devonian sediments were planked. These basins were probably trough subsidence areas (senkungs-feldter) in the Silurian platform. One such basin extended along the south-coast of New South Wales, from the neighbourhood of Tilba-Tilba, through Yalwal and Sassafras, then dipping under the Permo-Carboniferous coal measures of the Sydney basin, it reappears at Tamworth, on the flanks of the New England. Another Devonian basin now forms the Buchan and Bindi limestones of Victoria; another depression is represented by the Murrumbidgee limestones of N.S.W., and extended westwards to Canowindra and Wilcannia. Another great area of Devonian sedimentation was that of the Burdekin beds of Queensland. (*Fig.* 5).

Upper Devonian rocks also occur at Mount Lambie, N.S.W., at Back Creek and Clyde Mountains near Braidwood, N.S.W., and also between Orange and Wellington, N.S.W.

The earliest rocks of the Lower Devonian period were of an igneous nature, namely, the Snowy River porphyries of N.S.W.

Generally speaking, most of the igneous rocks of the Devonian period were of an acid character.

The nature of Devonian sediments (largely limestones and coarse sandstones) indicates shallow water and derivation from the denudation of and igneous rocks. The Devonian sediments therefore suggest that the volcanic ejacamentea and the igneous intrusions of the late Silurian

and Early Devonian were of granitic magma: by the same course of argument, we can suggest from the fine grained and dark nature of the slates of the early Silurian that the eruptions of that age and of the Ordovician were of basic magma.

Carboniferous.

In the Carboniferous period, the movement of the shoreline to the east was further accentuated. Along great stretches the area of maximum sedimentation lay far to the east of the present Continent. (*Fig.* 6). Isolated or semi-detached seas covered the New England area of New South Wales, and the Gympie area of Queensland. Great uplifts, accompanied by granitic intrusions, took place in the areas of maximum Silurian and Devonian sedimentation. Mountain building was in this period the result of earth folding processes, as instanced by the gigantic earthfolds in the Devonian beds underlying horizontal Upper Marine, near Braidwood, New South Wales.

A north and south running strip of the West Australian Continental mass was lowered sufficiently to become the depository of marine sediments.

During this period and the following, it is not unlikely that portions of Australia were connected with New Zealand, Fiji, and New Caledonia.

Permo-Carboniferous.

In the Permo-Carboniferous a shallow sea developed to the east of the main Devonian areas (*Fig.* 7), running north and south from the Sydney basin to the Dawson River in Queensland. This elongated basin was probably produced by folding, accompanied by faulting. In it were deposited the Permo-Carboniferous beds. This basin lay between the Gondwana land proper and the island continent between Australia and Fiji and New Zealand. It stood to these two landmasses in the same relation as the Sea of Japan does to Japan and China. It afforded a means for floating ice to be carried far to the north. [4]

Mighty upheavals took place in the Carboniferous and Permo-Carboniferous periods. Such elevated lands were built up that mammoth glaciers shed icefloes, which not only found their way far to the north in the South

Australian area, but even as far as Bowen in Queensland. The climate was so cooled that the rich flora of the coal measures was driven north, and likewise the mollusca and corals migrated to the north. Of corals only the hardy zaphrentis remained when the cooling of the climate set in.

During the Permo-Carboniferous cataclysms commenced the break up of the great Gondwana continent and the separation of Australia from India and South Africa was commenced.

At the close of this period, the New England area of N.S.W. became compressed between the adjoining segments of the earth's crust, so that the Permo-Carboniferous strata of this region were folded as intensely as the Silurian in other parts of Australia. [6]

To summarise the geological history of Palæozoic Australia, we may say :—

(1) The Pre-Cambrian is a conglomeration of formations—both acid and basic igneous rocks were intruded.

(2) The Cambrian was an era of uplift, Continental extension, and mountain building. Whether the Cambrian ice age was caused by earth movements having super-elevated many mountains and produced glaciers, or whether the cause of the ice age is due to any astronomical factors is hard to say. Eruptions and intrusions were of an acid nature.

(3) The Ordovician was a period of quiet subsidence over most of Eastern Australia; a great thickness of sediments accumulated. Vulcanicity was at a minimum, and the igneous masses which have been proved of this age were of an intermediate (andesitic) to basic character.

(4) The Silurian was a period of slow elevation of the sea floor over Eastern Australia, and of Continental extension by the piling up in the seas of the weathering products of the Continents. Vulcanicity became more and more marked towards the end of the period, and the intrusions and lavas became more and more acid in character.

(5) The Early Devonian was an era of rapid elevation in some parts, downthrow in others. Great folds and great faults were produced. The lavas, tuffs and intrusive rocks of the period were very acid in character.

The Devonian uplifts must have caused the isolation of many seas, for the Devonian sandstones of some parts

are like our Triassic rocks, very poor in fossils, and indicate deposition in a semi-brackish sea. The Devonian sediments, where not of organic origin, point to acidic eruptions and intrusions in this and the previous period.

(6) The late Carboniferous was a period of most intense folding and faulting, accompanied by igneous intrusions and volcanic eruptions of strongly acidic character.

(7) The Permo-Carboniferous was a period of general subsidence, accompanied by erosion of the lands and the piling up of sediments in the ocean. Volcanic eruptions took place far and wide in the regions of heavy sedimentation, and the lavas were all of an intermediate to basic nature.

Towards the end of this period the super-elevation of some landmass lying to the south-west of Tasmania, caused an Australian ice age. Evidences obtain at Bacchus Marsh, Victoria; Hallett's Cove, and other places in S.A., Lochinvar and Branxton in N.S.W., Bowen in Queensland, and the Irwin and Gascoyne Coalfields in W.A. [4 and 5]

In the foregoing notes, the following two points are of special interest:—

(1) The Continent moved in an easterly direction throughout the Palæozoic, and by the end of the Permo-Carboniferous, had captured more than the whole of the present continent, including many deep ocean parts. This is satisfactory evidence that Penck's theory of the permanency of ocean basins does not hold.

(2) Andesite indicates a subsiding and rhyolite a rising area.

The Mesozoic.

The Mediterranean Sea of Australia, shown on *Figs.* 7, 8, 9, commenced in the Permo-Carboniferous period, during which it was probably connected with the ocean by a south passage. Its oceanic connection to the south ceased with the dawn of the Mesozoic.

In the Triassic and in the Trias-Jura, it is probable that the main mountain ranges of Australia lay some distance out in the present Pacific Ocean, in the direction of New Zealand. Regional uplift took place over most of the coal-basin (Permo-Carboniferous) area. The upward movement was not of equal intensity in all parts.

During the Triassic, the Sydney basin not only lagged behind in the uplift, but was subsiding at intervals, so that during this period it was a shallow sea in which the Narrabeen shales, the Hawkesbury sandstones, and the Wianamatta shales were laid down. During the Narrabeen interval volcanic eruptions of an andesitic nature showered out ashes, which helped to build up the chocolate shales. The abundance of fossil leaves and wood in this formation indicates shallowness, proximity to land, and possibly nearly fresh water conditions, indicating that this area had participated for a time in the uplift of the late Permo-Carboniferous. The Hawkesbury sandstone system consists of coarse-grained sandstones, which, evidently, must have been deposited in a storm-tossed brackish sea, for the sediments carry no fossils except a few Macrotæniopteris leaves and fragments of fossil wood. Brackish water affords the most suitable habitat for thinshelled molluscs, and a shallow storm-tossed sea gives the best conditions for the complete destruction of shell remains by the grinding action of the sands. The frequency in the Hawkesbury system of false bedding is also indicative of changing currents and shallow water.

The Hawkesbury period was followed by an uplift which inaugurated a lake period in the Sydney area. In the lake then formed the Wianamatta shales were laid down. Mr. F. Chapman, F.L.S., concludes from his study of the fossil microzoa of the series that the Wianamatta shales were deposited in fresh or brackish water. [7] (Records Geol. Surv. of N.S.W., Vol. VIII., Part IV.) The other fossils of the formation, comprising thin-shelled mollusca and labyrinthodont remains, support this conclusion.

The Hawkesbury sandstone sea was at the start considerably larger than the area now covered by its formation.

Mr. W. S. Dun [8] has described fossil leaves in Lower Trias rocks from Benolong, in the Dubbo district. The sea gradually dwindled in size as elevation proceeded, and at last only the Wianamatta lake remained.

The elevation of the whole of the eastern belt of the present Australian Continent led to a relative depression of the interior, and in later Triassic times (the Trias-Jura

of Jack) an epicontinental sea formed in which the Trias-Jura rocks were laid down. This sea extended from the New England and Central tablelands in New South Wales west into Central Australia, thence north to the Gulf of Carpentaria. It reached the eastern margin of the present Continent in the Moreton Bay district of Queensland, whence a stretch of water extended south over the Clarence and Richmond districts of New South Wales.

The Trias-Jura sea is coextensive (*Fig.* 8) with the artesian areas of New South Wales and Queensland, and included also the Ipswich and Clarence coal-measures.

The bulk of the sediments deposited in this period consisted of coarse, silicious sandstones, distinguished by current bedding and scarcity of fossils. In parts, as on the Maroochy Beach of Queensland, fossil wood is plentiful. In isolated places leaves and thin-shelled mollusca are found. Evidently, the conditions prevailing in this expanse of water were similar to those prevailing in the Hawkesbury period over the Sydney basin.

The area subject to sedimentation in the Cretaceous period was almost identical with the Trias-Jura basin. (*Fig.* 9).

In the Cretaceous Mediterranean Sea of Australia were deposited the Rolling Downs formations, consisting of sandstones, marls and limestones, with marine fossils. The Cretaceous sea was probably connected with the ocean, both to the south and to the north.

The Rolling Downs are capped by the Upper Cretaceous or Cretaceo-Tertiary Desert Sandstones, fine-grained, magnesian sandstones—this formation often lies unconformably, and occurs in the form of broken ridges with flat summits and precipitous sides. The Rev. Mr. Tennison Woods, F.L.S. [9], considered the Desert Sandstone to be an early Tertiary volcanic tuff deposit, formed under terrestrial conditions, the false bedding being due, in his opinion, to wind changes (Proc. Roy. Soc. of N.S.W., Vol. XXII., p. 290). He considers also, that in the period of the Desert Sandstone, Australia was more elevated than to-day.

The theory of the volcanic origin of the magnesite of the Desert Sandstone is probably correct. Although the main trachytic eruptions of Eastern Australia were

older than the great basic flows, there is strong evidence in the Moreton and Fassifern districts of Queensland, and in the Canoblas, Nandewars, and Mittagong trachyte series in New South Wales, that the trachytic eruptive rocks were preceded by basic and ultrabasic intrusives, and flows quite distinct from the Miocene and Pliocene basalts. The age of this post-Jurassic volcanic period is probably not older than late Cretaceous, nor newer than Eocene.

The Cretaceous was a period of relative quiet, and the great continental rim elevated in the late Permian, Triassic and Trias-Jura periods was being worn down to base level. The formation of the Bolivia and Mole peneplains was completed in this period. (Andrews—Tertiary History of New England). An early Tertiary uplift followed, and this was accompanied by renewed degradation until the great Miocene peneplain of Eastern Australia was formed (Sandon and Stannifer peneplain of Andrews op. cit. [10], Monaro peneplain of Sussmilch [11]).

The first great basalt demonstration of the Tertiary occurred before the completion of Miocene peneplanation, and the alkaline lavas of Eastern Australia are usually regarded as early extrusives of that eruptive cycle, a view that assigns them to the Eocene or early Miocene periods. The later basalts succeeded, and are best regarded as late Pliocene. Their extrusion was followed or accompanied by great upheavals in some areas, such as New England.

The igneous activity of the Mesozoic periods has not left such striking evidence as the Tertiary volcanic action just referred to. The following clues are, however, afforded :

(*a*) The chocolate shales of early Trias (Narrabeen) age contain augite, and are probably andesitic tuffs.

(*b*) The Wianamatta shales do in many places near Penrith pass into tuffy shales. The nature of the shales themselves is indicative of derivation from basic volcanic rock. Some shaly beds in the Clarence series are likewise tuffy.

(*c*) The alkaline rocks of Eastern Australia were preceded by basic eruptions from which they are separated by at least one geological period. The magnesites of the Desert Sandstone may be related to these basic eruptives. [12]

From the nature of the Mesozoic sediments generally, we may conclude that the Mesozoic period was not characterised by intense vulcanicity, but some eruptions probably took place, such as the andesitic ejacamenta of the Narrabeen period, the basic tuffs of Wianamatta age, and others mentioned above. If any eruptions took place in the Hawkesbury period, they must have been of an acid nature. The Trias-Jura of the Clarence River district of New South Wales contains basic tuffs probably contemporaneous, and this is also the case with the Mesozoic rocks between Nambour and Yandina, Queensland. [13] The latter also contain rhyolites and associated tuffs, some of which show close resemblance to the felsitic tuffs at the base of the Trias-Jura in Brisbane. None of the rocks igneous definitely assignable to the Trias-Jura have an alkaline facies.

The points of major interest in connection with the Mesozoic rocks of Eastern Australia are :—

(1) Our Mesozoic sediments show no folding of consequence. Generally speaking, they show only slight dips, and have never been under the influence of tangential pressure like the Mesozoic sediments of the Alps, Himalayas, Java, etc.

(2) Even our Permo-Carboniferous rocks are only strongly contorted in the area of the New England district. Since the Permo-Carboniferous, Eastern Australia has been a stable unit of the earth's crust, if not actually rising, so that any sedimentation of late Permo-Carboniferous, and later age, is due to marine transgressions and epi-continental seas invading the landmass.

(3) Mountain building from the Permo-Carboniferous on has been by plateau uplift, not by folding, except in the New England, where tangential thrusts must have taken place in the Mesozoic. Faulting has aided in the formation of our mountains, but intense folding of this age has only occurred in the Northern Tableland of New South Wales.

(4) The most folded rocks of late Permo-Carboniferous and Mesozoic age are in a few small subsidence areas, among which the Gympie Goldfield [14], the New England, and the Ipswich Coalfield are prominent.

(5) The discovery by R. A. Wearne, of Fenestella in horizontal sandstones resembling Ipswich coal-measures,

near Mt. Barney, shows that the idea that the formations become progressively more and more folded as we go north towards New Guinea is not without limitations. [15]

(6) So little compression has there been since the ushering in of the Mesozoic in Eastern Australia, that artesian water is obtainable in Mezosoic rocks, but not in older rocks.

(7) The Desert Sandstone is a volcanic ash deposit, probably partly of late Cretaceous, partly of Tertiary age, as suggested by Tennyson Woods. [9]

THE BRISBANE AND THE GYMPIE ROCKS.

The veteran geologist of Queensland, Dr. Jack, classed most of the unfossiliferous schists of Queensland with the Gympie formation. In my paper, "The Metamorphic Rocks of Southern Queensland" [14], read before the A.A.A.S., Brisbane Meeting, 1909, I gave some weighty reasons for regarding the Gympie area as a small subsidence area, in which, by reason of depression and compression between adjoining blocks of the earth's crust, more recent formations were metamorphosed than in the more elevated blocks. Mr. Wearne's interesting discovery of Fenestella, near Mt. Barney, in almost horizontal sandstones confirms this view. [15]

I am inclined to regard the unfossiliferous Palæozoic beds between Brisbane and Coff's Harbour, and also those north of Brisbane in the D'Aguilar Ranges, and further north in the Yabba Ranges, etc., as a palæozoic complex of deep sea deposits, ranging from, perhaps,,Pre-Cambrian to Devonian or Carboniferous in age. These beds were elevated in late Carboniferous or Permian times, and portions of the area which they covered were submerged again by an epicontinental sea, when the great Mesozoic uplift of New England took place. The Clarence basin sandstones and Ipswich coal-measures were laid down in this epicontinental sea.

The Gympie beds of Gympie proper have been proved by their fossil contents to be equivalent with the Lower Marine beds of New South Wales, therefore Permo-Carboniferous. While it is not only possible, but probable, that large areas of Queensland were under shallow water in Permo-Carboniferous times, the beds laid down in that period have only been preserved in cases where they have been downthrown by trough faulting. [14]

The progressive increase of folding in Permo-Carboniferous rocks observed on going north from the Victorian to the Queensland border, reaches its climax in the Macleay-Manning and Southern New England districts of New South Wales. North of the Macpherson Range, the Permo-Carboniferous have only been materially disturbed in certain senkungsfeldt areas of small extent.

At Bega, in N.S.W. (*see Fig.* 11), we have the Ordovician rocks and igneous rocks of granite composition. Further north, in the Cobargo district, lightly folded Silurian shales (Narira schists) rest on the Ordovician. Still further north, not far from the Narrigundah goldfields, Devonian rocks appear, according to Anderson [16], sitting horizontally on top of folded Silurian. These Devonian rocks are seen at Braidwood and Ettrema, folded into huge anticlines and synclines. At Sassafras, horizontal Greta and Upper Marine rocks rest on them. That is the case in the Turpentine Range, Sassafras, the headwaters of the Clyde, Endrick and Danjera rivers. [17]

Still further north, as at Sydney and Maitland, the Permo-Carboniferous is lightly folded, and horizontal Triassic caps it. Still further north, on the Macleay and Manning Rivers, the Permo-Carboniferous is greatly folded. After that the intensity of fold movements diminishes progressively as we go north into Southern Queensland.

These facts may be stated in geological parlance in this way—

Sydney was the centre of a great geosyncline, the Bega-Monaro district and the Macpherson Range were the stable and resistant hinges [13] during all periods up to the Permo-Carboniferous. As sedimentation continued in the New England subsidence area during the Permo-Carboniferous, the uplift of this province took place in the Triassic. During the coalmeasures period, therefore, the centre of the geosyncline was near Sydney. East and west folding has taken place in the same way, Sydney being the centre of the depression. (*See Fig.* 11).

During the subsequent Triassic period, the Permo-Carboniferous sediments were folded in subsiding areas, and eroded away in other areas.

The synclinal nature of the Sydney basin closed with the Triassic period of sedimentation.

Prior to the Permo-Carboniferous, the whole of the East Australian Coast was a synclinal. The formation of the Bega-Monaro ge-anticline commenced in the early Palæozoic, and that of the Macpherson Range commenced in the Permo-Carboniferous.

To make the position clear, we may regard the movement along the whole Australian coast as either a movement upwards or a sinking.

From the point of view of uplift without tangential pressure, the Kosciusko mass has continuously risen since Ordovician times; proceeding northwards, uplift came later and later, post-Devonian at Narrigundah, post-Carboniferous at Nelligen and Braidwood, post Permo-Carboniferous at Yalwal, Ettrema, etc., post Triassic at Sydney. In the country stretching from Armidale on New England to the mouth of the Macleay and Manning Rivers uplift, accompanied by tangential compression, took place prior to the elevation of the Sydney area, namely in the Triassic period. This uplift was also experienced in Northern New England and the Macpherson Range, but was there only accompanied by tangential pressure in localised subsidence areas.

Compression is, generally speaking, the outcome of subsidence. When subsidence ceases, earth segments rise without being folded. Small areas lagging behind in the general uplift may undergo compression. Viewing the East Australian earth movements in the sense of downward movements, we see from the above that the maximum subsidence took place in the New England-Manning belt prior to early Triassic, when elevation commenced in this region.

The Sydney area remained submerged longer—in fact until the Triassic sediments had been laid down, when regional uplift set in; and south of Sydney the cessation of subsidence came earlier and earlier in geological time.

The Macpherson Range became a stable or rising area in late Permo-Cabroniferous.

During Mesozoic times, as well as Tertiary, the general tendency has been towards uplift and tension along the whole east coast of Australia, for the horizontal disposition of a formation of a given geological age may be considered as indicating that subsidence had ceased, or did cease, in

that period, though the area may have remained submerged for a while after.

Hence I deduce from the horizontal nature of Permo-Carboniferous beds at Mt. Barney [15], that in this period, or just before it, subsidence came to an end in this region; it does not follow that sedimentation must cease at the same time. It may persist for a whole geological period longer.

Queensland underwent the same general types of movement as New South Wales during the Palæozoic era. In the early Triassic, the super-elevation of some earth segments, such as New England, caused down warpings of slight amplitude, and in the depressions thus formed were the Triassic and Cretaceous rocks deposited.

Causes of Folding.

It has been argued that throughout the Palæozoic periods the ancestral Australian Continent was continually adding to itself on the eastern side. Adopting Kelvin's hypothesis of the origin of the continents, we may regard this original Australia or Gondwana Land as a floater, that is a portion of the earth's crust, which consisted of acid magma, and was specifically light, and therefore raised by flotation above the heavier magmas, or buoyed up by the heavier basic magmas beneath. As erosion was continually making it specifically lighter, and the detritus resulting from erosion was being piled up in adjoining seas, the process of erosion had the effect of causing continued elevation of the continental area and subsidence for a long period at least in the adjoining basins.

The elevation of the continental area would cease when the underlying basic portions of the earth's crust had consolidated and fallen under the influence of secular contraction.

The subsidence of the seabasins would cease when sufficient sediments had been heaped together for the depressed isogeotherms to reassert themselves.

The gradual rise of temperature in this great mass of cool sediments would cause first a general uplift, and, later, if upward expansion did not afford sufficient relief of pressure, folding of the sediments would ensue.

In this way the great accumulation of sediments round the margin of the old continent would be raised into mountain ranges, the continent advancing a few hundred miles in the direction of the former sea in each geological period.

The sediments of one geological period in this way became raised into a marginal buttress of mountain ranges in the next geological period. These mountain ranges in their turn would become subject to denudation, and the material derived from them would accumulate on the new continental shelf and in the adjoining deep; in its turn this new area of sedimentation would become a continental margin.

This view is opposed to the doctrine of Permanency of Ocean Basins advanced by that eminent geologist, Penck, but it derives strong support from the geological history of Eastern Australia. [For further discussion see 12].

Ocean basis are subsiding segments of the earth's crust, whose downward movement is probably due to rigid connection with the shrinking interior of the crust. In their downward sag, these segments sink from levels of lower earth temperature to those of higher temperature, with the result that such segments are fused below, and by reason of their expansion exert a lateral pressure on adjoining segments. In this way is produced a creep in the zone of rock flowage from the subsiding segments towards the rising segments. The displaced magmas become injected into cavities (maculæ), zones of no strain, and fractures in the continental margins, the rocks in which become heated by the injected magmas and consequently expand. A period of mountain building and folding, due to igneous injection as outlined by Reg. A. Daly [18], may therefore succeed or accompany the uplift and folding, due to rise of isogeotherms.

Mountain building by igneous injection, seems to have gone on extensively in the late Palæozoic and early Mesozoic in the New England area of New South Wales.

Folding only takes place in the superficial strata of a rising area (undergoing expansion due to rise of isogeotherms) under particular conditions, namely, when the area is a sunken fault block relatively left behind in the

general uplift, and so pinched in between two other blocks, and when the area is underlying mountain building by igneous injection.

Thus the elevated Triassic Hawkesbury sandstones of New South Wales are not superficially folded, nor are the Permo-Carboniferous sandstones of the Shoalhaven district (Nowra Grits). There have been no abyssal injections of magnitude introduced into them since their deposition. They have never been intruded by granites or diorites, or gabbros. This is also true for the Ipswich Coal Measures in Southern Queensland.

But the Ipswich Coal Measures are locally disturbed to a considerable degree at Ipswich in proximity to a fault which suggests that this portion of the area is a Senkungsfeldt. They are also slightly folded in the D'Aguilar Range, near the Glass House Mountains, the uplift here having probably igneous injection as the immediate causal agent.

Those portions of a continental margin which have their cracks and maculæ infilled by magmas creeping along the zone of flowage became cemented together, and persist as land for many periods, while those portions which are not affected by igneous injections are weakened and tend to become downfaulted areas (Senkungsfeldter).

In illustration of this statement, it might be pointed out that the Kosciusko fault block, the Central Tableland, and the Northern Tableland in N.S.W., abound in huge granitic intrusions, as is also the case with the Stanley River block of South Queensland (Woodford Peneplain).

In his presidential address to the Linnean Society this year, Mr. C. Hedley gave further particulars of his view that the Tasman deep is a pressure trough, and endeavoured to show that the physiographic features of New South Wales are due to a pressure emanating from the Tasman deep [19 and 20].

There is no doubt about the existence of a great fold in the Mesozoic rocks of this part of Australia. The Hawkesbury sandstones and the Nowra Grits have in general a gentle dip towards the sea, and the Peneplains formed by the truncation of the original fold in middle Tertiary times have their eastern margins depressed beneath the sea by a further accentuation of the fold movement.

But this fold is of such a gentle nature, and the dips produced so slight, that the movement may be more aptly described as Andrews has done as plateau uplift [Andrews, 1].

No superheated magmas have yet worked their way up in these sediments and caused expansion and intense folding, but very late Tertiary faults have produced Senkungsfeldt areas (as described by Sussmilch, 11], some of which may, perhaps, in a future period, become so squeezed as to be intensely folded. Up to the present, the uplift has affected the superficial strata only so far as to produce in them faults and great masterjoints. As shown by Sussmilch (op cit) and T. G. Taylor [21], the direction of the rivers of Southern N.S.W. is induced by these faults, while in the present writer's opinion, the great canons which dissect the Southern coastal tablelands and Blue Mountains of N.S.W. follow principally great joint cracks of the sandstones. These joint cracks, as seen by the writer at Ettrema Canon, often coincide in position with Palæozoic faults, and may owe their origin to slight displacements along these old fault lines. Joints and faults in a homogeneous formation constitute the lines of weakness, along which streams are able to work down and dissect a plateau.

Folding of a compressive nature in an area like that of the Blue Mountains of N.S.W., is very deepseated, and, in the writer's opinion, pressure is exerted in the deeper portions of the earth's crust from the sea, towards the land, from the great subsiding basin of the Tasman Sea towards the Continent. In this respect, the writer agrees with Hedley, and disagrees with Andrews, who believes that the continent exerts a pressure in the direction of the ocean. The contour of the east coast of Australia would seem to lend colour to Andrews' hypothesis, but, as pointed out by Hedley, in an interesting discussion, the apparent convex curve of the East Australian coast becomes two concave curves if we analyse the soundings in the adjoining Pacific Ocean, for a bar of shallow water runs from Point Danger eastwards in the direction of Fiji.

The deepseated landward pressure in itself largely accounts for the buoying-up of the Continent.

THE BREAK-UP OF GONDWANA LAND.—FAULTING.

The coasts of Western Australia, India, Arabia, and East Africa are unmistakably faulted coast lines [Atlantic type, see 12].

Recent faulting is still enlarging the Indian Ocean. Madagascar is a horst, and the Mozambique channel is a Senkungsfeldt, the fault which separated the former from Africa having taken place in Pleistocene times.

The faulting in progress at the present time in the Rift Valley of Africa—a region of great modern earthquakes—is a later instalment of the same process of disruption.

Gondwana Land existed from the early Palæozoic (Cambrian) to the Permo-Carboniferous as a compact landmass. In the Carboniferous, subsidence areas of the nature of trough-faults had already commenced, and over some of them passed transgressive arms of the sea: thus not only in Africa are almost horizontal Carboniferous marine sediments met with, but in West Australia a long strip, occupying mainly the west coast of modern W.A., was submerged in the Carboniferous, and during part of the Permo-Carboniferous, and again at intervals in the Mesozoic. The land connection between Australia, Africa and Antarctica began to break down during these periods, though island bridges probably remained until the end of the Mesozoic, these accounting for the African affinities of the West Australia flora.

This disruption was, no doubt, due to secular contraction. The interior of the old Continent became unstable, and was downthrown as soon as the cooling of the deeper portions of the earth's crust commenced to make them contract. Portions of the upper crust became separated from the cooling, lower portions by the formation of shrinkage cavities (maculæ), some of which were not reached by igneous invasions from the zone of flowage. Thus the upper shell become unsupported, and fell in. The rim of the old Continent was largely strengthened by igneous injections, and thus escaped the general collapse. In this way the old complex of Western Australia, and that of Western Tasmania consist very largely of igneous materials.

It has been suggested that in the Permo-Carboniferous and early Mesozoic periods the Continent extended far into the present Pacific Ocean, and may have been connected both with Fiji and Antarctica or New Zealand. [22, C. Hedley, A.A.A.S., 1909.]

These extensions have been taken away again by faulting.

It should be here mentioned in explanation of the distinctive nature of the West Australian flora, that although all our late Permian and Mesozoic sediments are of a epi-continental nature that is formed in epi-continental seas, Western Australia had, prior to the Tertiary period, very little land connection with eastern portions of the Continent.

The present appearance of the eastern coast of Australia is in many parts that of a strongly faulted coast-line. As shown by Sussmilch, the Southern Tablelands of N.S.W. [11] constitute a blockfaulted peneplain. I have myself corroborated faulting of this kind by describing instances in the country west of Jervis Bay. [17]

A further and more striking example was seen on a later visit to the Bega district. The Bega coastal district is separated from the Monaro Tableland by a linear though facetted fault scarp, which has downthrown the eastern block about 1,500 feet relative to the Monaro block. The topography is identical on the coastal plain and Monaro Tableland. This fault scarp runs parallel with the Continental shelf, and it is more than likely that some of our steep declivities on the Continental shelf are similar, but submerged, fault scarps.

E. C. Andrews has given a very complete account of Tertiary faulting [1].

Mountain Ranges and Direction of Folding.

As already stated, Andrews has regarded the convexity of the Australian coast towards the Pacific as evidence of folding towards that deep. The veteran geologist, Suess, has drawn similar conclusions from the curvature of mountain ranges, arguing that the East Asiatic mountain festoons and island festoons indicate folding towards the Pacific. Mr. C. Hedley has argued against this view, and I think with ample justification that fold mountains will tend to form a girdle round buffers or

bulwarks in the shape of compact and resisting earth segments, the more pliable rocks being moulded against the resisting object.

There are, no doubt, cases of surface folding, in which the fold movement is exerted from the land in the direction of the sea, as in *Fig.* 13 (*a*), where two earth segments, a rising one, A^1, and a subsiding one, B^1, are in contact. At their junction the beds will be in some cases overfolded towards B^1; in some places fractured and overthrust faults may develop. This type of earth structure is in evidence at Penrith, in the Blue Mountains, N.S.W., and in the Main Range, Fassifern district, Q. In such cases, we always have a broken plateau, different parts of which are rising or subsiding at different rates.

More usually, we have surface folding conforming to the type illustrated in *Fig.* 13 (*b*). A synclinal area undergoing expansion B^1 is folded up against the hard-resisting Palæozoic rocks, A^1. It is clear that folding of this kind may form either a concave or convex range in the direction of thrust depending on the configuration of the opposing mass. (*See Fig.* (*b*), (*c*) and (*d*).)

In my paper on the Geology of the East Moreton and Wide Bay Districts, I presented the view that the folding of the Mesozoic rocks of the D'Aguilar Range and the Blackall Range was caused by pressure from the East. This view I still adhere to, and these ranges have a slight convexity to the East. As shown in *Fig.* 12, the south spur of Mt. Mee has small cappings of Trias-Jura rocks elevated high above the surface of the coastal plain. The pressure from the East must have been rather deep seated, the surface formations being at the time in a state of tension.

In discussing the merits of the theories advanced by Hedley, Andrews and others on the direction of pressure, it is the deepseated and not superficial pressures that count, for as already shown, the surface formations of Eastern Australia have throughout Tertiary times been in a state of tension, and plateau uplift has been the main cause of mountain building. Plateau dissection accounts for the curvature of our ranges.

For this very reason it seems absurd to draw inferences as to the direction of existing and Tertiary pressure distribution from the configuration of existing mountain

ranges. Bends concave to the east occur where areas of soft Mesozoic sediments or Permo-Carboniferous rocks have offered an easy task to the forces of erosion. The ranges consist largely of barriers of hard palæozoic rock, whose directions of folding offer no clue to the tertiary direction of pressure.

It seems, therefore, that in the East Australian area we cannot deduce the direction of earth pressures from either the curvature of mountain ranges or from the fold lines in the Palæozoic rocks, but only from the differential movements of fault blocks.

The existence of the high plateaux along the eastern rim of the Continent seems to the writer evidence for believing that the pressure came from the east. The greatest uplift would be in the blocks in closest proximity to the source of pressure. Experimentally this may be verified by pushing a piece of paper away from you while the other end of the paper is clamped under your inkpot. At first it will fold upwards at the end from which the thrust is exerted, then another fold appears near the object offering resistence to the thrust and finally the whole sheet is uplifted. If you try to fold a slightly elastic yet brittle object in the same way, it will fracture before the first fold (that near the source of thrust) is complete. Consequently the block faulting in Eastern Australia, along the Pacific rim, is further evidence for deepseated pressure from the East.

Where least resistance was offered to the thrust by Palæozoic massives, the main uplift was further from the source of pressure. This will account for the wide expanse of lowland country between the Darling Downs and Moreton Bay.

The writer is, therefore, not in agreement with Mr. Andrews' deductions regarding lines of pressure. Probably his lines of pressure from the Southern Ocean towards the interior of Australia are correct, but his lines of pressure from Eastern Australia towards the Tasman Sea should probably be reversed. [23]

In 1902 [23], Andrews attributed the rugged nature of the North Queensland coast to recent faulting. In the writer's opinion, this view is corroborated by the fact that the Barrier line of reef is separated from the coast

by deep water, and not by a sea of coral islands. This implies fast movement such as would be produced by faulting. If the movement had been slow the corals would have been able to keep building up at the same pace as the the downward sag, and islands would be scattered through the whole expanse between the reef and the mainland.

Fig. 13 gives the writer's idea of this block. In it we have a repetition of the processes which build up mountain folds and caused the gradual easterly aggrandisement of Gondwana land.

In North Queensland, in the Tertiary period, a plateau uplift gave rise to a plain extending as far as the present Barrier Reef. This plain was faulted, and the seaward portion sagged downward. During this process, volcanic extravasation took place. The subsiding block is getting heavily sedimented, and its western portions are at the same time having their isogeotherms raised by the intrusion of basic magmas as indicated by the recent basalt flows and hot springs of N.Q. The conditions are, therefore, favourable to the productions of great folds in this block, which in due course will become uplifted and a part of the continent. The down movement of the block will continue until rise of isogeotherms in the sediments is able to overcome the pressure of the sediments.

It strikes the student of geology that folding movements were more intense in the Palæozoic periods than later in the earth's history. This, if so, would seem to corroborate Kelvin's theory of the origin of the earth, for it would indicate that in the Palæozoic, the earth's crust was more plastic and the zone of flowage nearer to the surface than at present.

VULCANICITY AND PETROLOGY.

The petrology of the sedimentary rocks of each of the great Palæozoic periods is naturally very similar throughout Eastern Australia. Though similar rocks are not always contemporaneous, and sometimes one series, sometimes another, is missing in various parts of the continent, still a general resemblance exists between the sedimentary formations of each period for all parts on the same belt of sedimentation, and this lithological similarity can often be verified by the discovery of fossils.

As there was a steady displacement of the shoreline in an easterly direction, we should expect the more easterly portions of Eastern Australia to have deep sea deposits, characterising the early Palæozoic and shallow sea deposits typical of late Palæozoic. The late Palæozoic rocks of the eastern part of N.S. Wales and Queensland should, therefore, be lithologically similar to the Cambrian of Central Australia; thus, conglomerates formed a dominant series in the Cambrian of South Australia and Western N.S. Wales, and conglomerates are typical of Permo-Carboniferous and Carboniferous in more eastlying parts.

Volcanic rocks because of their want of fossils are more difficult to study, but their study also leads to important deductions.

It appears that intermediate igneous rocks, that is to say, those which are allied to diorite and andesite in magmatic character, are characteristic of any era of subsidence. We see such rocks at the present day extruded from the active volcanoes of the New Hebrides, the Tongan Islands and the Kermadecs in the great Pacific subsidence area. Rhyolites and Granites are more typical of an era of quiet uplift and of mountain building by rise of isogeotherms. Alkaline rocks, both basic and acid, are typical of a period of general uplift accompanied by faulting and Senkungsfeldt formation over portions of the area. Basic lavas belong chiefly to periods of plateau uplift. To illustrate by modern examples—we have in the North Island of New Zealand, an area of post-tertiary elevation, where many volcanoes are even to-day disseminating acid lavas. Alkaline rocks are poured out by the Antarctic active volcanoes on the troughfaulted perimeter of a plateau which has undergone very recent uplifts. [24] We have them under similar conditions in Italy and East Africa.

Basalts of an alkaline facies are to-day emitted from the volcanoes of Tonga and Samoa, in which there is probably a present tendency to general uplift, but calcic and magnesic basalts are often poured over subsidence areas in the period preceding their re-elevation.

Let us now consider igneous action in the history of Australia, investigating period after period, commencing with the Cambrian.

CAMBRIAN.

Acidic igneous rocks supposed to be of this age exist in Western and Central Australia. Similar rocks were not intruded in Eastern Australia till many periods later. They belong mainly to the Upper Silurian period in Central New South Wales, to the Carboniferous in Eastern New South Wales, south of the Sydney basin, and in part at least to the late Permo-Carboniferous or early Mesozoic in New England and Southern Queensland.

ORDOVICIAN.

In Victoria, Professor Skeats [25] has referred the Heathcotian Series to this period. The igneous rocks of this series were of an intermediate to basic nature, and chemically rich in magnesia. From this, one would expect the Victorian area to have been undergoing subsidence during Ordovician times. The evidence of the associated sediments confirm such a supposition.

In Central New South Wales we have contemporaneously interbedded andesites in the Ordovician near Orange, Forbes and Mandurama. Here, too, the sedimentary rocks would seem to indicate a period of subsidence.

UPPER SILURIAN.

In Victoria some of the Snowy River porphyries and felsites (all very acid rocks) may belong to this period.

In New South Wales we have acid submarine tuffs of this age at Wellington, and banded rhyolites and dacite tuffs at Yass.

The sedimentary rocks of the Upper Silurian in Victoria and Central New South Wales show that a shallowing of the sea had commenced.

In North Queensland too, in the Chillagoe district, we have granites and felsites of this age.

In the New England district and the north coast of N.S. Wales, where subsidence was still in progress, the intrusive rocks being dioritic (blue) granites.

DEVONIAN.

Professor Skeats has demonstrated that some of the Snowy River porphyry series of Victoria were erupted in the Devonian.

Many granite intrusions in N.S. Wales are supposed to be of this age, to which, as well, the Snowy River porphyries of N.S. Wales are referred.

Professor Skeats has assigned to the Lower Devonian, the dacite and quartz porphyrite series of Dandenong Hills; to the Middle Devonian, the felsite series of Buchan.

Upper Palæozoic.

To the Upper Devonian or Lower Carboniferous, Professor Skeats has assigned great areas of rhyolite, quartz porphyry and basalt at Mount Wellington, and in the Grampians. [25]

Many of the N.S. Wales granite intrusions have been referred to the Devonian, as have also many of the granites of Southern Queensland.

By far the most of the granites of N.S. Wales are connected with the folding of the Devonian beds, and took place prior to the deposition of the Upper Marine. The granites of Yalwal, Sassafras, Narriga, Moruya, Moonbi Ranges and many more, have proved to be post-Devonian and pre-Greta, and the probability is that they are all of Carboniferous age.

Carboniferous rhyolites occur associated with conglomerate formation to the west of the New England, in the Nandewar Range.

Melaphyres (basaltic) were at this time poured out in the Avon River district of Victoria.

The north-eastern portions of New South Wales were still subsiding under a load of sediments, and the andesitic eruptions of the Clarence town series were extruded over the Stroud district and eastern New England.

In the Permo-Carboniferous period, the south coast district of N.S. Wales was subjected to eruptions of Alkaline, sub-alkaline and basic rocks. [26] These eruptions initiated the period of uplift.

Mesozoic.

The chocolate shales of the Narrabeen series contain volcanic minerals, and are probably to a great extent of tuffaceous origin.

Generally speaking, the Mesozoic period was in Eastern Australia notable for the rareness of indications of volcanic action.

Some of the acid granites of the New England may perhaps be of late Permo-Carb. or of early Mesozoic age.

Some of the upper beds of the Clarence (Ipswich) Series seem to have been tuffs.

Marks has demonstrated the existence of dolerites of Triassic age in more or less isolated patches of the Ipswich coalfield. [27] Further, we have the period of Trias Jura sedimentation in Southern Queensland ushered in by eruptions of felsite (Brisbane tuffs), dacite, quartz porphyry and andesite (Eumundi series).

Yet Mesozoic eruptions were extremely localised. Volcanic debris or lava is seldom met with in boring in Trias Jura or Hawkesbury formations.

It was only in the late Cretaceous that vulcanicity became more intense, as evidenced by tuffy material in the Desert Sandstone, the trachytic tuffs in the Upper Cretaceous of the Mackay district (Q.). [For references see 9 and 12.]

It has only been shown that in the areas distinguished by Alkaline eruptives in Tertiary time, monchiquites, essexites, picrites and teschenites were erupted during late Mesozoic times [12]; the Alkaline rock being frequently preceded by ultrabasic eruptions which were separated from the main period of Alkaline effusions by a short period of erosion.

In Tasmania the Mesozoic, or at all events a portion of it, probably the Jurassic, was characterised by extensive volcanic extravasation. The great diabase sills of that State are usually assigned to the Jurassic.

Tertiary Vulcanicity.

The absence, except in very few cases of fossiliferous aqueous rocks in the regions of tertiary volcanic action, makes it extremely difficult to assign exact ages to Tertiary igneous rocks.

The Kainozoic eruptions may be roughly divided into the Older Basalts, the Alkaline Rocks and the Newer Basalts.

(*A*) The Older Basalts. In many cases the exact ages of these rocks cannot be determined on stratigraphical evidence. In some cases an age can be assigned to them on physiographic evidence.

E. C. Andrews [1] states that the Leads of the "Older Volcanics" are characterised by the presence of abundant plant leaves, lauraceous types predominating. Fruits and seeds, he says, are characteristically absent.

Their geographic position is above the level of the

great Tertiary peneplain of Eastern Australia, this peneplain having been excavated out of "Older Volcanics," palæozoic and mesozoic rocks indifferently. They, therefore, lie on basalt capped hills dotting the peneplain.

As examples, Andrews mentions Dargo High Plains, Vic.; Kiandra, Older Macquarie and Hawkesbury Leads [Mount King George (?), Bald Hills, Hill End, etc.], Older Tingha and Emmaville Leads (N.S.W.)

Skeats [25] describes numerous occurrences of Older Volcanics in Eastern Victoria. According to this author older basalts are not petrologically distinguishable from the newer, except by their finer grain size and greater decomposition.

In New South Wales, the basalt of the Sydney basin, found in dykes around Sydney, as necks at Hornsby, Prospect, Minchinbury, Dundas, etc., and as more extensive cappings on Mount Hay, Mt. Tomah, and Mount King George in the Blue Mountains, are in part referable to this series. These basalts have decidedly alkaline affinities, containing variously sodalite, analcite and hauyne.

The Orange basalts underlying the alkaline pile of the Canoblas must also be put in this class. They were erroneously mapped by Mr. Sussmilch and myself as later than the alkaline eruptions, but Mr. E. C. Andrews discovered, by physiographic methods, that we must have made a mistake, which was confirmed by Messrs. Andrews and Sussmilch in subsequent studies in the field. These basalts are in some instances characterised by the presence of melilite and fayalite. Probably the melilite basalts and the tuffs of Hobart and the Alkaline basalts of Shannon Tier, Tasmania, are roughly contemporaneous.

It has been demonstrated by Andrews [1], that many of the New England basalts and much of the Darling Downs basalts of Queensland belong to the Older Volcanics. Mr. R. A. Wearne, B.A., and the writer have also seen evidence in the Fassifern district of extensive intrusives of basic magma in very late Mesozoic, or more probably Early Tertiary time, before the Alkaline rocks of that district were poured out.

The Rhyolites of the Macpherson Ranges, between Queensland and New South Wales, antedate in part at least the extrusion of the Alkaline rocks. [15] From

physiographic considerations it seems likely that an early Tertiary age must be assigned to them.

(*B*). THE ALKALINE ROCKS. [29] It is quite possible that the lavas of this series were in part at least contemporaneous with the Older Volcanics. Although petrological analogies have tempted the writer in the past to consider all the Alkaline rocks of Eastern Australia to be of identical age, their more detailed physiographic study renders this view questionable.

Alkaline rocks of Tertiary age exist in Victoria, at Mount Macedon, and detailed investigations in this important type district have led Skeats to the conclusion that their age is Middle Tertiary. They are certainly mountains of accumulation and not residules.

In Queensland, the writer has investigated the Glass House Mountains and the Yandina district volcanoes, all of which have been satisfactorily shown to be true mountains of accumulation. Their age, probably, antedates the formation of the Middle Tertiary peneplain, which is represented in this district by the Woodford peneplain, for although dykes of alkaline rocks occur on the peneplain surface, no true lavas and tuffs of an alkaline nature have been detected on this level. A monoclinal fold, along the D'Aguilar and Blackall Ranges, broken by occasional faults, has depressed the coastal region so as to preserve it in the volcanic representatives of the alkaline rocks. This fold must have been forming at the time when the alkaline rocks were erupted, and if some of these eruptions were not actually submarine, as maintained by J. Malcolm Newman, B.E., there can be little doubt that the whole present broad coastal belt was submerged in late Tertiary times, and has only recently been re-elevated. The late uplift can date back only to the Pleistocene, as far as can be judged by the evidence of the marine shells of the raised beach deposits.

The Mount Flinders and Fassifern Alkaline rocks, studied by Mr. Wearne and myself, are probably also in part of early Tertiary age, slightly antedating the formation of the Middle Tertiary peneplain. There is, however, strong evidence that in this region the eruptions lasted long enough to leave some of their accumulations on the peneplain surface. They were, therefore, partly of Middle

Tertiary age. In this case, as in that of the Glass House region, a monoclinal fold accompanied by extensive fractures was produced in the Main Range, parallel to, and in part, along the line of igneous activity after the period of vulcanicity.

The Nandewars, the Warrumbungles, and the Canoblas in New South Wales, are probably also of Lower-Middle Tertiary age, though the Canoblas appear rather younger than the others. These mountains post-date the formation a peneplain carved in the Nandewars out of Palæozoic and Trias Jura rocks, in the Warrumbungles out of the Trias Jura rocks, and in the Canoblas out of the metamorphic rocks and Older Volcanics. The peneplain was undergoing re-elevation at the time of the eruptions, for both in the Nandewars and in the Warrumbungles, the volcanic ejacamenta frequently infill erosion hollows in the peneplain surface. The age of this peneplain was probably Late Cretaceous or Lower Tertiary age, like the Mole peneplain; there being no indications in these regions of an older peneplain surface, the writer has always hesitated to consider this peneplain the equivalent of the Stannifer (Miocene). If the writer is right in this interpretation, it follows that during the great early Tertiary elevation of New England and Middle Tertiary peneplanation, these volcanic groups escaped wholesale degradation by being situated in the Central Australian trough, which was a local baselevel (probably largely lacustrine, as hinted by abundant gypsum deposits in the west), for the erosion of regions which participated in the Pliocene uplift.

The fossil leaves collected in the Warrumbungle tuffs by the writer are most closely allied to those of the Older Volcanics.

Andrews has suggested to the writer that more or less dissected peneplain underlying the volcanic pile of the Warrumbungles is the equivalent of the Stannifer. This view would place a post Miocene age on the volcanic rocks, and assign them to the newer volcanics. Fossil evidence, as well as physiographic, discountenance this view.

The alkaline rocks of the Mittagong district, N.S.W. [30], and the tinguaites of Kosiusko [31], and of Barrigan [12] are probably of an early Tertiary age.

The Newer Volcanic.

The rocks are mainly basalt of a more or less porphyritic nature. They cover enormous areas of Eastern Australia. In age they postdate the formation of the Middle Tertiary peneplain, and the eruptions were in progress during the great Pliocene uplift. The leads of newer volcanics are consequently buried channels below the peneplain level or resting immediately upon it : their fossil contents are characterised by an abundance of fruits and seeds similar to those of tropical Australia to-day. Lauraceous types are characteristically absent.

The whole of the extensive basaltic plain of Western Victoria, and many areas in Eastern Victoria belong to the Newer Basalts. In this state eruptive activity continued, as in the Mount Gambier District of South Australia, into late Pleistocene and recent times. Remains of the Dingo (an animal presumed to have been introduced by man) have been found in the tuff.

On the Monaro in N.S. Wales and in the New Englaud extensive eruptions took place in late Pliocene or early Pleistocene. Most of the Darling Downs basalts were probably erupted at the same time. At the same time extensive sheets were poured out in North Queensland (as at Cairns, Atherton, Geraldton, &c.).

Pleistocene and recent erosion has only had time to slightly modify the original surface. There has been no peneplain formed since these volcanic extravasations. The very level nature of the Darling Downs, and of the tableland on the Blackall Range and of the tablelands on similar ranges is due to the fact that the lavas flowed over a peneplain surface only, slightly dissected, and being of a liquid nature, the lava outpourings made a level surface. The eruptions were dominantly fissure eruptions.

Early Tertiary peneplanation was followed by the eruption of the Older Basalts, which usually cap deep leads of this age.

The Valuable Minerals of Eastern Australia.

Closely connected with the petrology of our continent is the study of our mineral deposits of economic value. The genesis of ore deposits is also intimately bound up with structural geology.

It is convenient to consider separately the groups of non-metallic minerals and metallic minerals or ores.

I. Non-Metallic Minerals.

The principal non-metallic mineral is coal. Of less importance are oil shale, phosphatic rock, opal, diatomaceous earth and graphite.

(*a.*) The occurrence of coal depends on the burial in some bygone epoch of the requisite thickness of plant remains, considerable subsidence following so as to allow a great thickness of sediments to accumulate on top of the seam. Under these conditions, the weight of the superincumbent strata, together with the heat appertaining to the depth to which the organic bed was depressed, have produced the necessary pressure and heat to compact and dehydrate the deposit.

Folding and metamorphism in the zone of flowage have not affected the coalfields, for these processes or even a moderate amount of igneous intrusion would completely turn coal into graphite. The moderate folding and the measure of igneous intrusion that have affected the Gympie goldfield, have turned several coal seams into plumbago, which, as is well known, occurs interbedded with Phœnix slates.

Faulting, especially block or trough faulting, is the process most frequently leaving its mark in the coal measures.

Coal occurs in Eastern Australia in the Permo-Carboniferous (Newcastle and Illawarra districts of N.S.W.; Bowen, Little River, Oakey Ck. and Dawson River in Q.); in the Triassic (in the Ipswich and Barrum districts of Q., the Clarence district of N.S.W., and in the Otway and Wannon and Gippsland districts of Vic.; Leigh's Ck., S.A.; Fingal and Jerusalem, Tas.); and in the Tertiary rocks we have hydrous coals, the best of which are the lignites of Morwell, Vic. There are numerous other localities of considerable economic importance, but the main point for us to recollect that vast areas of Eastern Australia represented by our coalfields have undergone no contortion since the deposition of the coal. The western half of the Australian continent has been free from such forces even longer. Indeed there is no reason why Carboniferous and Devonian coals should not be found in Western Australia.

The Australian coalfields were probably in most cases formed by the decay of plant life in swampy freshwater areas.

There is strong evidence that considerable plant life, sufficient to give thick coal deposits, existed in parts of Eastern Australia, as far back as the Silurian period; but the deposits then formed have been changed to graphite by subsequent regional metamorphism.

The writer had occasion some time ago to visit a deserted turquoise mine, near Bodalla, on the South Coast of N.S.W. He observed that the turquoise ($AlPO_4 \cdot Al(HO)_3 + H_2O$), existed in the form of small segregations, together with pyrites in a graphite bed, associated with quartzites above, and black slate below, of Silurian age. The copper and iron (in part) had evidently been introduced during the metamorphic processes, and the former had chemically combined with the phosphoric acid present in the organic matter, which probably was a coal bed at the time. The same metamorphic processes that produced the mineralisation changed the coal to graphite.

The association of the graphite with quartzite, like coal with sandstone, renders it more probable that the carboniferous matter was of plant, than of graptolitic origin.

(*b*.) Oil Shale. In N.S.W., the chief oil shale deposits consist of algal remains [32] (Reinschia Australis), and were probably a freshwater deposit.

The Tasmanian "tasmanite" deposits are supposed to have formed in salt or brackish water.

The conditions for the preservation of oil shales are the same as for coal.

Petroleum oils have not yet been tapped in Australia, but there are strong possibilities that such will yet be found.

The conditions for the formation of petroleum oils are (*a*) the existence of beds of coal, oil shale or other organic remains; (*b*) regional metamorphism of just sufficient intensity to give rise to folds and sufficient heat to sublime the oils into the anticlinal maculae, or (*c*) volcanic intrusions causing the distillation of organic rocks.

In south-eastern Queensland oil may yet be found in the Triassic Walloon coal measures under the Birnam

Range, in the Permo-Carboniferous rocks at a depth under the Eastern Darling Downs, and in the Triassic rocks of the East Moreton and Wide Bay districts.

In New South Wales the Carboniferous and Permo-Carboniferous rocks of the Stroud and Taree districts offer most promise.

(*c.*) Opal, being a product of mineral spring action, has no great geological importance, so will be dismissed in this paper.

(*d.*) Phosphatic rocks have been discussed in another paper by the writer. (These preceedings, 1909.)

(*e.*) Diatomaceous earth of economic value occurs chiefly in direct association with our late Tertiary basalts. It is a deposit formed of the test of organisms which lived in siliceous hot springs. The writer has had excellent opportunities to verify this by his studies in the Warrumbungle Mountains, where petrified wood and hyalite (water opal) are invariably associated with the rocks surrounding the diatomaceous earths.

II. Ores.

The following points are of importance in connection with the study of our ore deposits :—

1. Mineral lodes are mainly confined to folded areas. This is why coal and gold are seldom found together.

2. The minerals were introduced during a period of igneous intrusion.

3. The intrusions take place chiefly in the portions of the folded earth segment, which are most remote from the source of the folding force.

4. Well defined fissure lodes have the same general direction as the trend lines of folding in the same regions. In the immediate proximity of great igneous intrusions, they may take varied directions, diverging from the intrusion. (See L. K. Ward, "Geology of the Heemskirk Massive," A.A.A.S., 1911, Sydney.)

5. The direction of the zone of mineralisation is that of the fold lines and major faults.

Considering Australian ore deposits, it is interesting to note that in the eastern half of the continent, most were formed during the great abyssal injections of the Carboniferous and early Mesozoic periods.

To the Carboniferous belong the Tasmanian ore deposits; the Victorian goldfields; the Yalwal, Braidwood, and other southern goldfields of N.S.W.; the Moruya, Ettrema and Colerado mineral fields of the south coast of N.S.W.; the Grafton Copper Mine (?), Cloncurry, Chillagoe, the Etheridge, Hodgkinson, Palmer and "Towers" fields.

To the early Mesozoic period belong the ore deposits of Gympie, Q., and most of the New England deposits.

The deep leads of Eastern Australia show us that it was not until the early Tertiary uplifts that the continent was sufficiently dissected for the reefs to shed their gold on the surface.

In Western Australia, the igneous injections giving rise to ore bodies were of very early Palæozoic age. Consequently there are sedimentary rocks as old as Cambrian in W.A. with alluvial gold. The silver lead deposits of Broken Hill also belong to an earlier era than those of Eastern Australia.

Certain facts in connection with ore deposits in Australia are of interest without being quite apropos in this paper, such as:

1. The association of complex ore (lead, zinc, copper, silver, arsenic) with limestone as at Mungana, Q., Ettrema, &c., N.S.W., and with garnet rock (metamorphosed limestone), at Broken Hill.

2. The possibility that Gympie gold is due to chemical precipitation of gold in magmatic water, by the carbonaceous Phœnix slates and graphite beds; that Chillagoe is a contact deposit; that the Towers gold is probably due to physical changes undergone by magmatic waters, &c.

Brief Review of the Tertiary.

E. C. Andrews in his "Tertiary History of New England," and in the "Geographical Unity of Eastern Australia," has given a very detailed and complete history of the Tertiary, and full description of the processes whereby land and sea forms were shaped. No complete description will, therefore, be essayed here.

It is sufficient to say that most Australian geologists are converging to the belief that there are definitely two Tertiary peneplains represented in our scenery.

The first existed in early Eocene times, during which a warm climate existed throughout Australia.

The Cretaceous sea had vanished, all but a gulf extending over Western Victoria and Riverina. (*Fig.* 10.) The Central Sea had become silted up or slightly elevated, so that a desert or a series of salt lakes resulted. There were no mountains in Australia, for all elevations had been base levelled during the Cretaceous period of sedimentation. In the waters, about Table Cape, Tasmania, the foraminifera exhibited tropical affinities, and resembled those now found around Torres Straits. The plant life was of a tropical or semi-tropical character, as shown by their remains in the older leads, and so essentially similar a flora existed throughout the eastern part of the continent that it is safe to suppose that geographical barriers, such as high mountains or deserts, were not in existence.

Then followed the early Tertiary uplift which affected the whole rim of the continent. The more central portions of Australia participated only to a minor extent.

A long period of stability then came, during which the uplifted peneplain was dissected and worn down again to the form of a peneplain. This stage was reached probably in the Miocene.

Then followed an other great uplift, probably Pliocene, and at the same time were erupted the Newer Basalts.

The period of the Newer Basalts was probably very wet, and the Australian interior was experiencing a wet climate at the same time, and during most of the Pleistocene period as well. As evidence of the lacustrine state of the interior during late Tertiary and Post-Tertiary times, one might quote the widespread existence of gypsum deposits formed in former lakes, and the great extents of Black Soil Plain, which were formed largely from volcanic detritus, carried down by mightier streams than those which hold sway to-day.

Following the Pliocene uplift and the great basic outpourings of lava, came a period of contracting, fracturing and block-faulting of the surface strata of the earth's crust in the newly uplifted regions. Numerous downthrows (senkungsfeldter) occured as a result. The block-faulting in the southern tablelands of N.S.W. has been ably described by Sussmilch [11], a long list of probable faults

belonging to this late geological age has been prepared by Mr. E. C. Andrews. [1]

It is the writer's opinion, as enunciated in one of his papers [29 (*a*)], that an arid climate was experienced in Central Australia, immediately after the uplift of the Cretaceous basin in the late Mesozoic and early Tertiary times. During most of the Tertiary period, however, conditions were extremely wet, a fact borne of it by the sedimentary banding of clays and sands of fluviatile and lacustrine deposition, under the great Red Soil Plain, as well as by the Black Soil Plains and gypsum beds. The writer has had an opportunity to study these deposits at Nyngan, on the eastern flank of the Cobar massive, as well as on the western slopes of the Warrumbungles.

The cause of the aridity of the Cretaceo-Eocene and the present periods is undoubtedly, in part, a geographic one, connected with the uplift of a girdle of tablelands round the margin of the continent at the end of the Mesozoic, and again at the close of the Tertiary period. Partly, too, the cause is meteorological. During the two arid periods, the climate of the Australian zone has been dominated by entirely different atmospheric movements to those prevailing in the Middle Tertiary. As shown in a paper by the present writer to this Society, it is likely that this wet period and the Pleistocene glaciation of Kosciusko was, in all probability, a cosmic one, the nature of which is still doubtful, though it must be admitted that peculiarities in physical geography alone could have brought about the result.

The effect of Tertiary changes on the life of this continent have been most pronounced.

The disappearance of the Cretaceous basin caused a migration of those hardy forms of plant life, which had developed on the barren soils of Western Australia into the Eastern parts, where they expelled and subdued the Indo-Malaysian type of flora. The latter has only succeeded in maintaining its predominance on rich scrub soil in leached basalt and alluvial areas.

The invaders probably consisted of eucalyptus, casuarinæ, acacias, proteaceous plants, zamias, and epacrideæ. The eucalyptus may possibly have originated in south-eastern Australia, and this may also be the case

with the casuarinæ, but the others are almost certainly invaders from the west.

The plants which they drove back were largely lauraceæ, as is well demonstrated by the fossil leaves of the older deep leads and the trachytic tuffs of the Warrumbungles.

The grasses now dominant in Eastern Australia probably also originated in the west, especially those of the interior.

The wet climate of the Middle Tertiary drove the arid climate plants, which had established themselves over the raised Cretaceous basin, into the Eastern coastal regions, while tuft grasses, similar to those of the Plains of Promise, took possession of the drier parts of the interior.

The re-elevation of the coastal rim, with the restoration of arid conditions on the inland plains, brought victory to the saltbush and similar orders, and caused a return to some extent of the eastern flora.

Messrs. R. H. Cambage, F.L.S., and E. C. Andrews, B.A., F.G.S., are at present carrying on the interesting and important work of tracing the descent of Australian forest timbers, and investigating what geologic and physiographic causes brought about the specific differences now obtaining between the trees of different parts.

Late Pliocene uplift led to the creation of three climates. (1) coastal, moist and warm ; (2) tableland, cool and moderately dry ; (3) inland plains, dry and with seasonal extremes of temperature. This movement, according to Cambage and Andrews, caused a differentiation of our trees into three groups. Each genus developed species suited for each of these climatic zones. Pleistocene faulting, according to the same authors, separated still further members of the same group in such a way that further specific differences arose. In other cases faulting allowed an intermingling of coastal and inland types, as was the case on the Cassilis geocol [33], where the western flora mingles with that typical of the Hunter River Valley.

The work of Mr. Cambage promises to cast considerable illumination on obscure problems of Tertiary geology, thus he shows, from the distribution of the Casuarinæ, that a portion of south-eastern Australia must have been lost by faulting in post-Tertiary times.

Mr. C. Hedley and others are carrying on similar work with regard to zoological distribution. Mr. Hedley maintains that in the Middle Tertiary, when a wide peneplain covered Eastern Australia and a lacustrine region occupied the interior, the giant marsupials, known from our newer leads and bone beds, roamed far and wide, and fed on the plenteous herbage produced by the moist climate.

The elevation of the tablelands decimated them, for the lacustrine interior became an arid plain on which they died out of starvation, the table lands were too cold and did not produce the proper herbage for these huge animals. The great basaltic extravasation caused further destruction to them, and the surviving remnant was slaughtered by the blacks.

An interesting effect of the basaltic outpourings on the temperate tablelands of Eastern Australia was the destruction of the Eucalyptus flora, and the failure of that flora to reassert itself. In coastal regions, basalt country in the state of nature soon becomes covered with scrub, as we call tropical moist climate jungles. Given good soil, this flora can hold its own against the hardy typical Australian flora. But on the tablelands the climate is too dry and cool for tropical jungle ; and inland the climate is also too dry and extreme, so that basalt flows in these regions never become scrub covered. [35] The basalt lands therefore remain treeless plains, for the Eucalyptus and Acacia groups requires a loose loamy soil, but our basalt soils are heavy, and shrink on drying. The cracking of basalt soils may be the cause of a normal tree growth failing to assert itself, and young trees having their roots torn by the cracking of the soil. Again, it is possible that the black colour and high lime content of black soil may have some inhibitory effect on the germination of seeds of plants typical of poorer country. This latter problem has never been investigated.

Some of the Tertiary changes of geography of Australia must have been witnessed by the aborigines.

In Victoria, and in the Mount Gambier district of South Australia, basaltic volcanoes were in active eruption when the Australian aborigines and their dingoes were in possession.

The faulting down of Bass Strait saved a remnant of the original inhabitants of Australia (the Tasmanian aborigines) from utter destruction by the invading Australian aborigines.

Torres Strait was probably also formed during the occupancy of Australia by the blacks.

STREAM DIRECTIONS.

Great changes in the drainage systems of Australia resulted from the Pliocene uplift. Andrews has shown that some streams cut down rapidly enough to keep pace with the uplift. He quotes the Hawkesbury River as an instance. Other rivers were diverted from their courses.

The parallelism of many rivers with the coast has given rise to much controversy and speculation. Hedley [19 and 20] sees in it evidence of a great fold rolling in on Australia from the Pacific. Andrews is inclined rather to consider these remarkable streams due to faulting.

[36] Woolnough and Taylor have suggested that the Hawkesbury (Wollondilly) formerly tapped the Shoalhaven, Tuross and other south-coast rivers. But this great Wollondilly river was beheaded by coastal streams which were rapidly cutting back in a westerly direction. These streams having a steep fall to the sea carved canons rapidly, whereas the sluggish Wollondilly cut down but slowly, and fell an easy prey to piracy.

The writer [13] has shown that the Upper Mary River (rising in the Conandale and Yabba Ranges), Queensland, was once part of the Maroochy River, flowing through the Eumundi Gap, in the Blackall Range. Here, undoubtedly, the uplift of the coastal plain of East Moreton has tended to aid a capture of consequent by subsequent streams.

In New South Wales, where the reverse has taken place, we must look for a different cause for the parallelism of the early streams with the coast. To the writer, the most reasonable explanation seems as follows:—The elevation of the Miocene peneplain carved in Permo-Carboniferous and Mesozoic sandstone gave rise to the production of cracks and joints in the sandstone. The major lines of weakness thus formed followed the structural directions of the subjacent old rocks. Master joints in the sandstones closely followed fault lines, anticlinal axes and similar structural lines of the older rocks. Along such cracks

the earliest streams took their courses, and as elevation progressed, they often worked down through the sandstones into the folded formations, where their tendency to follow structural lines would be accelerated.

Our inland areas not having undergone much vertical movement in the Tertiary, possess very old streams, many of which probably date back to the Eocene.

The Namoi and its tributaries are very old subsequent streams. The Castlereagh is younger, for its original course was filled up by the volcanic pile of the Warrumbungle Mountains, and the river had to wander round this group in a spiral.

Present Day Movements.

Only a few salient points will be mentioned. C. Hedley and T. G. Taylor [37] have demonstrated that the east coast of Australia is in the main subsiding, as shown by the existence of the Barrier Reef and numerous drowned River valleys. David and Halligan [38] have proved a coastal subsidence of over 100 feet in post-Tertiary times for the Port Jackson, Hawkesbury and Hunter River inlets. Andrews [77] has shown that a slight elevatory movement followed in extremely recent times. The writer has proved [13] that the coasts of Moreton Bay are being slowly uplifted, and this holds true for all the coast line, from Point Danger to Great Sandy Island.

The Victorian coast line is subsiding from Cape Howe to Cape Otway. That of Western Australia is undergoing elevation.

Faulting is still in progress in the regions round the Gulf of St. Vincent, South Australia, as shown by frequent earthquakes in that region.

Artesian Water.

Of all Australian geological questions, none are so interesting and valuable as those connected with the origin and distribution of Artesian Water. In Eastern Australia, Artesian Water is confined to formations later than the Permian. In Western Australia it has been obtained in rocks as old as Cambrian, and large supplies exist in the Carboniferous of the Gascoyne River district.

The fact is pretty well established that one of the essentials for the existence of Artesian Water is a pervious

stratum of rock lying between two impervious strata. It is also established that formations pervious enough to become artesian beds have never been strongly compressed by earth movements or regional metamorphism. They have been areas of tensional strain and fracture since the artesian beds were laid down, for which reason they in most cases signify that elevation relative to adjoining segments of the earth's crust, has been the dominant earth movement.

In Eastern Australia Artesian Water may be found in the Triassic (as in New South Wales, see Pittman) [39], and in the Cretaceous (see Jack and Etheridge, Geology of Queensland.) Tertiary formations may also contain Artesian (subartesian) Water, as in the Riverina and parts of Victoria.

Two theories as to the origin of the Australian Artesian Water beds have been advanced, neither of which has been properly established.

The one school of geologists, supported by Pittman and David, believe in the meteoric origin. They believe that the pervious beds are continuous over vast areas, and have outcrops on the surface near the edge of the artesian basin, at which outcrops water is taken in from streams that cross them. Water then rises in the bores by hydrostatic pressure. The comparative freshness of the water is supposed to be due to its having outlets to the sea in the Gulf of Carpentaria and Great Australian Bight. This view receives some support from the rapid dwindling of Queensland rivers which cross the Blythesdale Braystone (Cret.) in Queensland; from a similar disappearance of the streams that enter the Pilliga Scrub from the Warrumbungle Mountains, in N.S.W.; from the drying-up of the Castlereagh River, west of Mundooran, and many other such occurrences.

The other school follow, Professor Gregory [40], in believing that the water is nascent plutonic water, given off by cooling igneous magmas at great depths. According to this view, the porous artesian beds act as sponges, absorbing the water which rises as subterranean springs along joint cracks and other flows in the formation. Gas and steam pressure would be the expelling forces.

Gregory's view receives considerable support from the following facts :—

(1) Springs are rare in the artesian area, but abundant outside this area. They frequently occur on the summits of high mountains, where the catchment area is insufficient to account for their permanent flow. [29]

(2) The water bearing beds of the Artesian area are often sand and boulder drifts, and not sandstone: they frequently seem to be mere lenticular patches.

(3) Very pervious rocks like the Blythesdale Braystone are rarely met with.

(4) Artesian Water is generally hottest and purest when tapped from the lower strata: while the water with most solid matter in solution comes from the upper strata.

If the meteoric theory is right, we should expect the water to become more and more impure the farther it is from the intake, and the shallow bore waters should be the freshest. The reverse happens to be the general rule. On the Plutonic theory, the superficial beds contain water which has travelled much further through assimilable sediments, and should therefore be most saline. Experience shows this to be the case.

Probably each of these two rival theories is true for some places. While recognising the meteoric theory as affording a correct explanation for some cases, the writer firmly believes that the plutonic theory must account for the origin of many bore waters.

Proof of a conclusive nature will not be possible until a systematic survey is made of the artesian basin, including chemical and physical investigation of the waters at different depths.

It would be well to state here that whether the meteoric or plutonic theory be found to be true for the greater part of our artesian basin, there is little danger of speedy exhaustion of the water supplies. It is true that bores have frequently ceased to flow, but in every case the cause has been either (1) corrosion of the casing allowing the water to escape into dry sandbeds; or (2) the scouring of a water channel between the casing and the walls of the borehole, allowing similar escape of the water. Sometimes the latter cause of stoppage has been aided by tinkering with the bore, *e.g.*, by temporarily shutting the bore.

When a flow ceases in this way it can usually be got from the same stratum by sinking another bore a few yards away.

APPENDIX.

REFERENCES TO LITERATURE (Reference number given in square bracket, thus [1]).

ANDREWS, E. C.
"An Outline of the Tertiary History of New England."
Rec. Geol. Surv., N.S.W., 1903, Vol. VII. [10].
"Report on the Drake Mining Field."
Mineral Resources No. 12, Geol. Surv., N.S.W. [6].
"Geographical Unity of Eastern Australia."
Jour. & Proc., Roy. Soc. of N.S.W., Vol. XLIV. [1].
"Preliminary Note on the Geology of the Queensland Coast."
Proc. Linn. Soc. of N.S.W., Vol. XXVII., 1902. [23].

ANDERSON,

CHAPMAN, F.
"Microzoa from the Wianamatta Shales."
Rec. Geol. Surv., N.S.W., Vol. VIII., Pt. 4. [7].

CARNE, J. E.
"The Kerosene Shale Deposits of N.S.W."
Geol. Memoir, No. 3, Geol. Surv. of N.S.W., 1903. [32].

CARD, G. W. (with L. F. Harper and J. B. Jacquet).
"The Geology of the Kiama-Jamberoo District."
Rec. Geol. Surv. of N.S.W., Vol. VIII., Pt. 1, 1905. [26].
"Notes on Some Sydney Basalts."
Rec. Geol. Surv., N.S.W., Vol. VII., Pt. 3. [28].

CAMBAGE, R.
"Notes on the Native Flora of New South Wales."
Proc. Linn. Soc., N.S.W., 1905, Part 3. [34].

DUN, W. S.
"Notes on Some Lower Mesozoic Plants from Benolong, Dubbo District."
Rec. Geol. Surv. of N.S.W., Vol. VIII., Part IV., 1909. [8.]

DAVID, T. W. E. (with F. B. Guthrie and W. G. Woolnough).
"The Occurrence of Tinguaite on Mount Kosciusko."
Jour. Proc. Roy. Soc. of N.S.W., Vol. XXXV. [31].

DAVID AND HALLIGAN.
"Recent Subsidence on the Coast of New South Wales."
Jour. Roy. Soc. of N.S.W. [38].

DAVID: Report of Glaciation Committee of A.A.A.S.
Promo-Carboniferous Glaciation. [5].
"Geological Epochs," Add. at Mexican.
Geol. Conference, 1907. [4].

DALY, R. A.
"Mountain Building by Igneous Injection." [18.]

GREGORY, J. W.
"The Dead Heart of Australia," [40].

HEDLEY, C.
"A Biological Scheme for the Mid-Pacific."
A.A.A.S. Reports for 1909. [22].
Pres. Add. Linn. Soc. of N.S.W., 1910. [19].
Pres. Add. Linn. Soc. of N.S.W., 1911. [20].
"The Barrier Reef," (Hedley and Taylor).
A.A.A.S. Reports for 1907. [37].

JENSEN, H. I.
"Distribution, Origin and Relationships of Alkaline Rocks."
Proc. Linn. Soc., N.S.W., Vol. XXXIII, Pt. 3, 1908. [12].
"Geology of Parts of the East Moreton and Wide Bay Districts."
Same Proc., Pt. 1, 1906. [13].
"The Metamorphic Rocks of Southern Queensland."
A.A.A.S. Reports, 1909. [14].
"Geology of the Country Behind Jervis Bay."
Jour. and Proc., Roy. Soc., N.S.W. [17].
"Notes on Quartz Reefs in the Nelligen District."
Same Jour. [17].
"Geology of Warrumbungle, Nandewar and Canoblas Mts., N.S.W., and Mt. Flinders, Q.
Proc. Linn. Soc., N.S.W., 1906, 1907, 1908, 1909. [29].
"The Vegetation on Basalt Soils."
Proc. Linn. Soc., N.S.W., Pt. 4, 1909. [35].

MAWSON, D., and TAYLOR, T.G.
"The Geology of Mittagong."
Jour. and Proc. Roy. Soc. of N.S.W., Vol. XXXVII. [30].

MORRISON,
"Volcanic Necks of the Sydney District."
Rec. Geol. Surv. of N.S.W., Vol. VII, Pt. 4, 1904. [28].

PITTMAN, F.
"Artesian Water."
Jour. and Proc., Roy. Soc. of N.S.W., 1907, Vol. XLI. [39].

SKEATS, E. W.
"The Volcanic Rocks of Victoria."
A.A.A.S., 1909 Meeting, Brisbane. [25].

SHACKLETON, E.
"In the Heart of Antarctica." [24].

SUSSMILCH, C. A.
"Notes on the Physiography of the Southern Tableland of N.S.W."
Jour. and Proc. Roy. Soc. of N.S.W., Vol. XLIII. [11].

TAYLOR, T. G.
"The Physiography of Yass-Canberra,"
Bull. 6., Commonwealth Bureau of Meteorology. [21].
"The Correlation of Coal, Contour, and Climate."
Proc. Linn. Soc., N.S.W., 1908. [33].

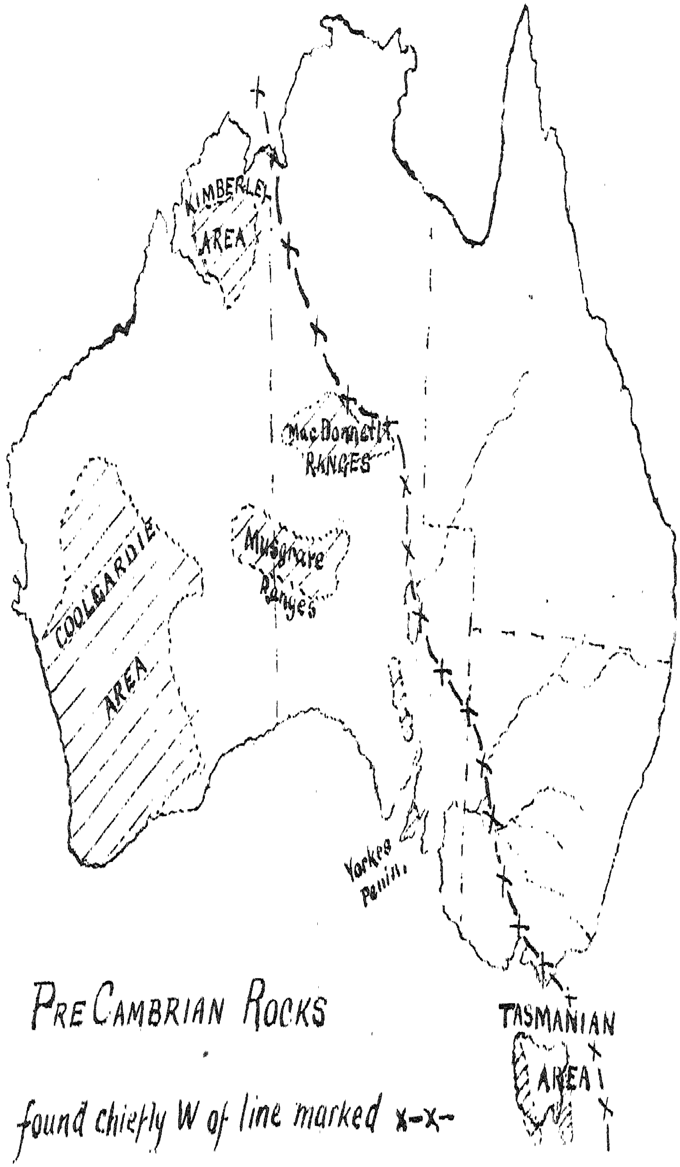
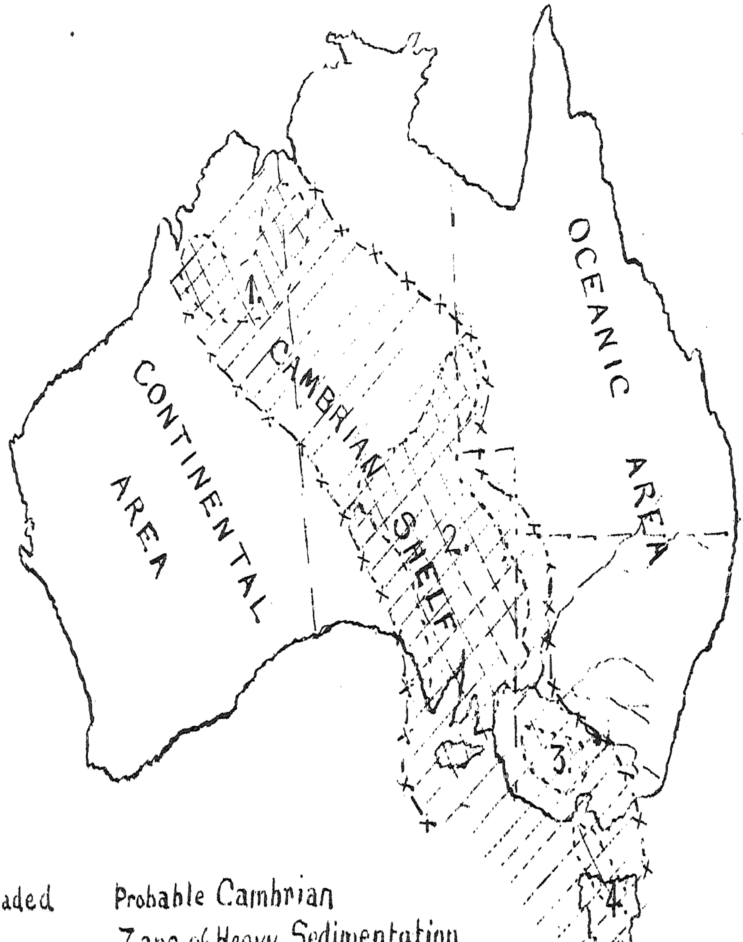


Fig 1. PreCambrian Rocks

found chiefly W of line marked x–x–

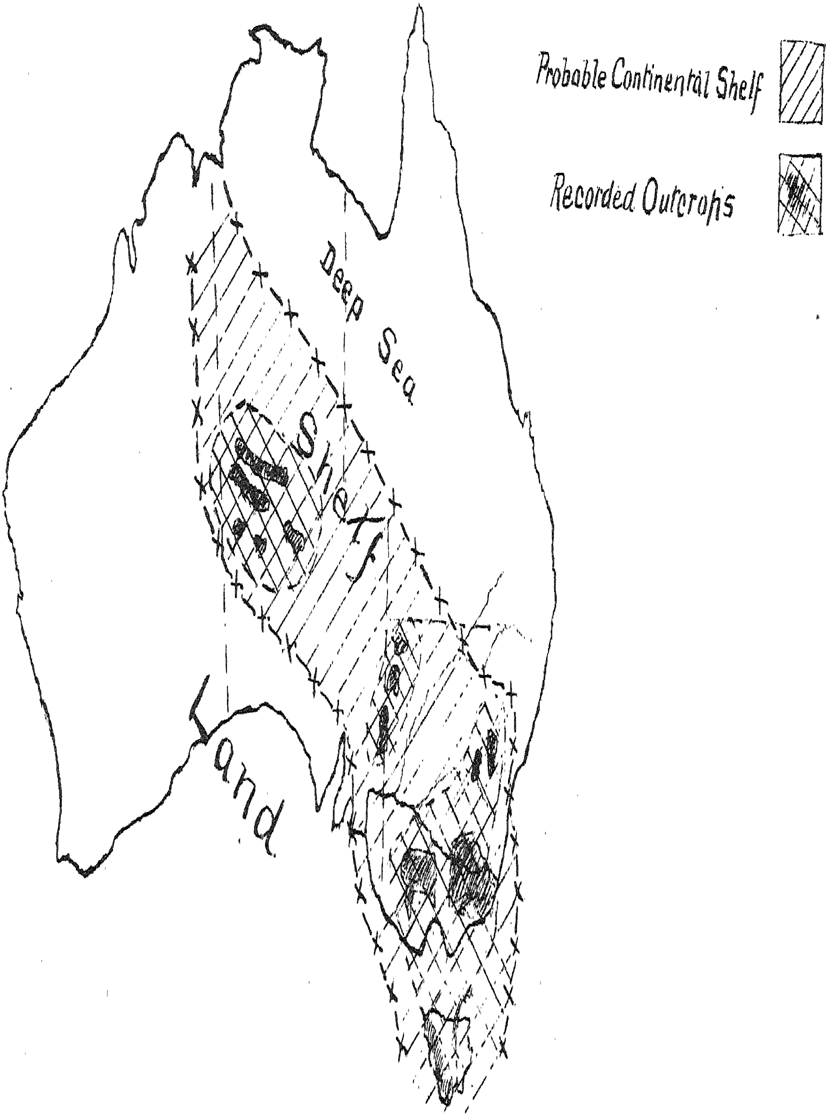
Fig 2. CAMBRIAN SEDIMENTATION.



Shaded — Probable Cambrian Zone of Heavy Sedimentation

1. Kimberley District, W.A..
2. Mt Lofty to Petersburg, S.A
3. Heathcote District, Vic..
4 Caroline Ck., Tas..

Fig 3. ORDOVICIAN SEDIMENTATION



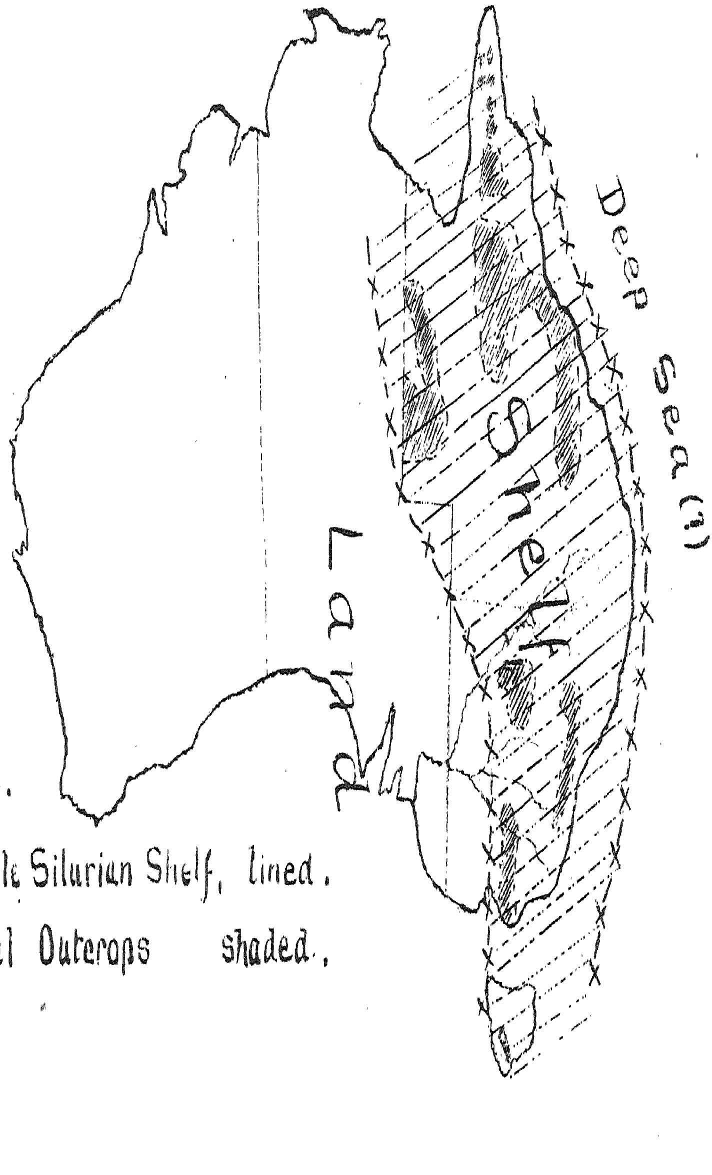


Fig 4.

Probable Silurian Shelf, lined.
Actual Outcrops shaded.

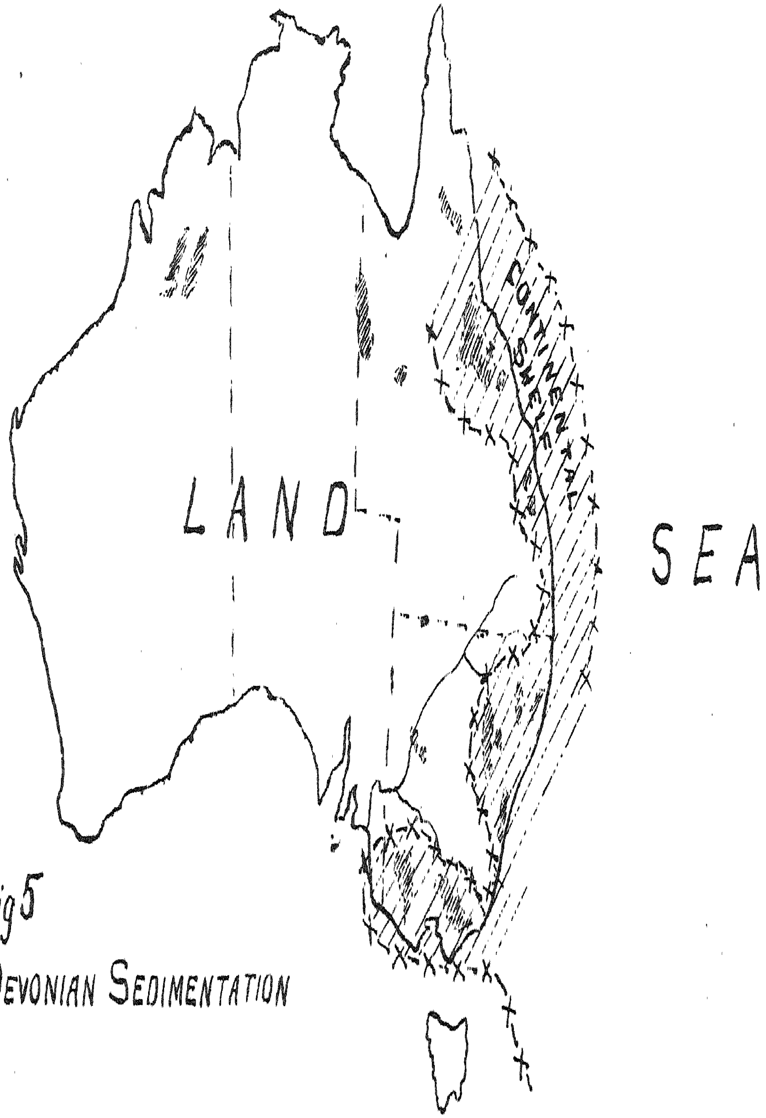


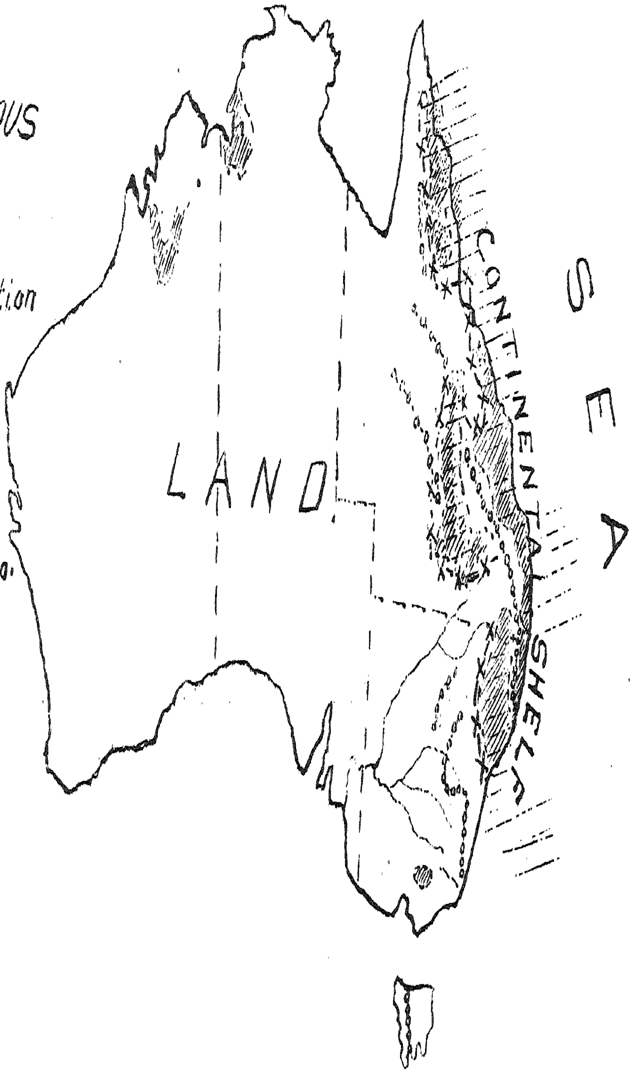
Fig 5
DEVONIAN SEDIMENTATION

Fig. 6.

CARBONIFEROUS AREAS.

Heavy Sedimentation shaded.

Lines of Carbs. Folding, Granitic Injection & Ore Deposition o.o.o.



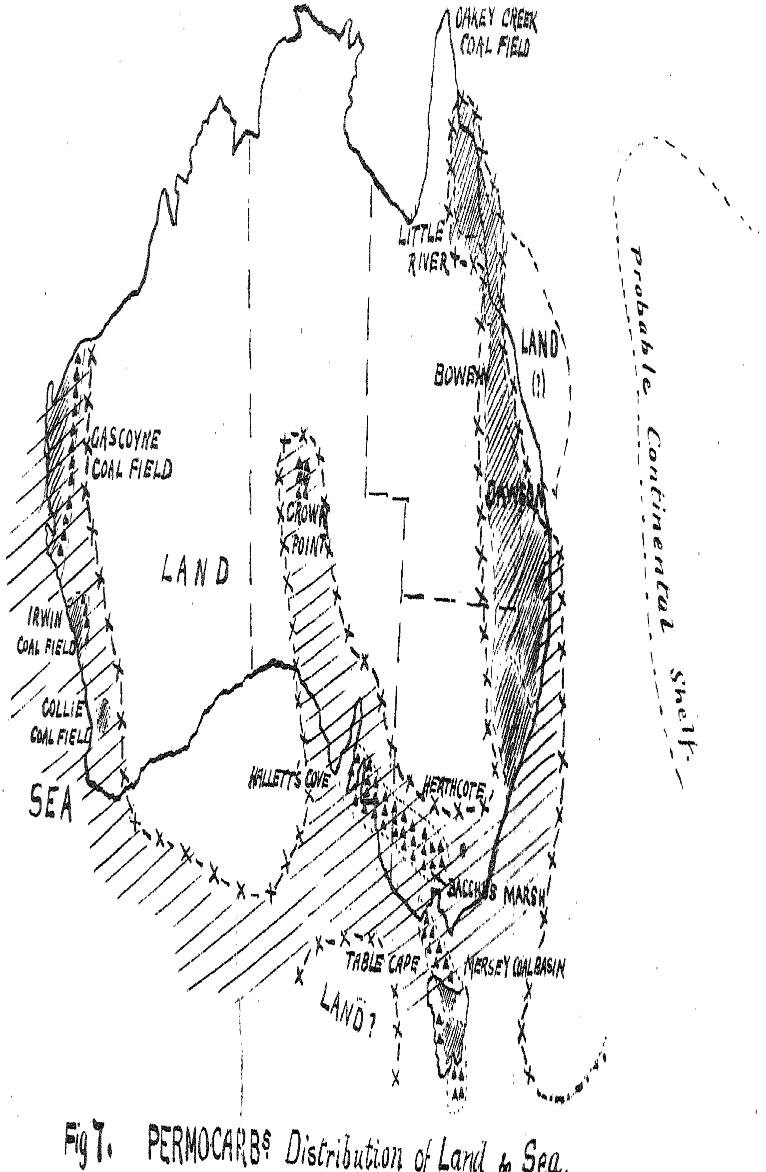


Fig 7. PERMOCARB^s Distribution of Land & Sea.

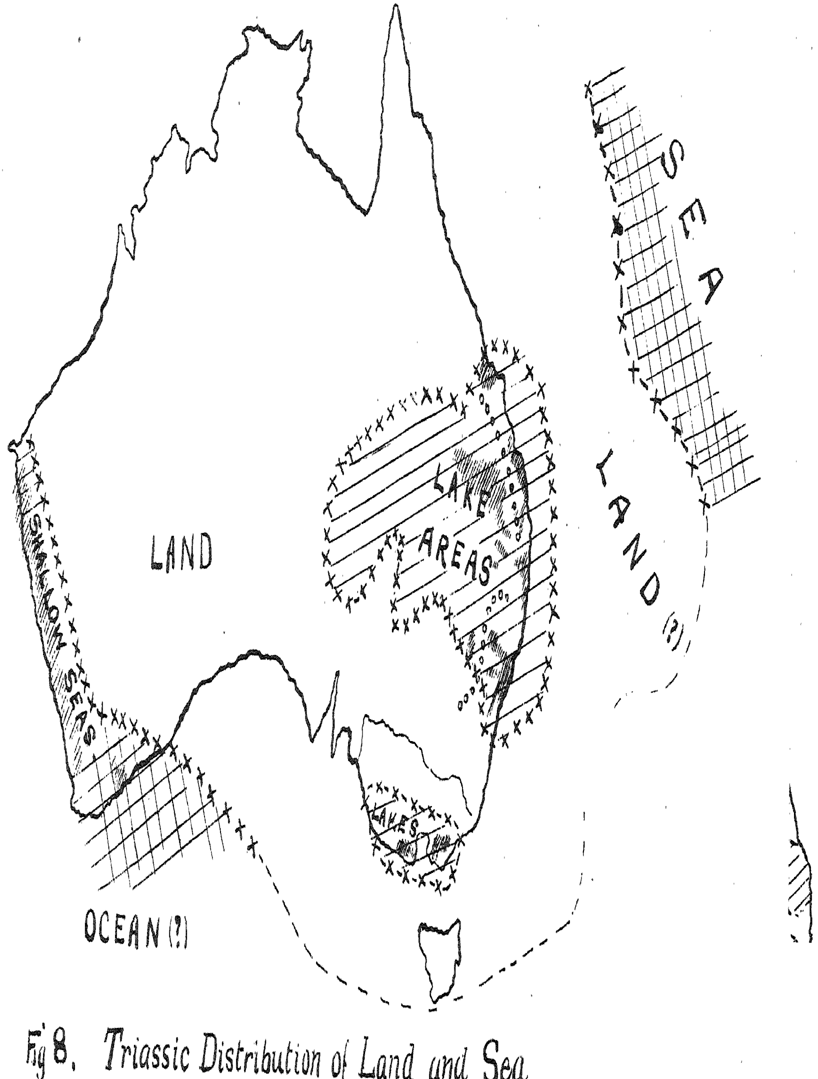


Fig 8. *Triassic Distribution of Land and Sea*

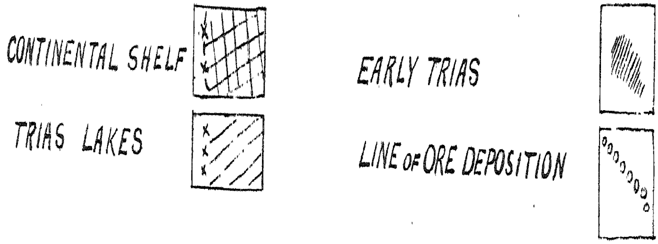
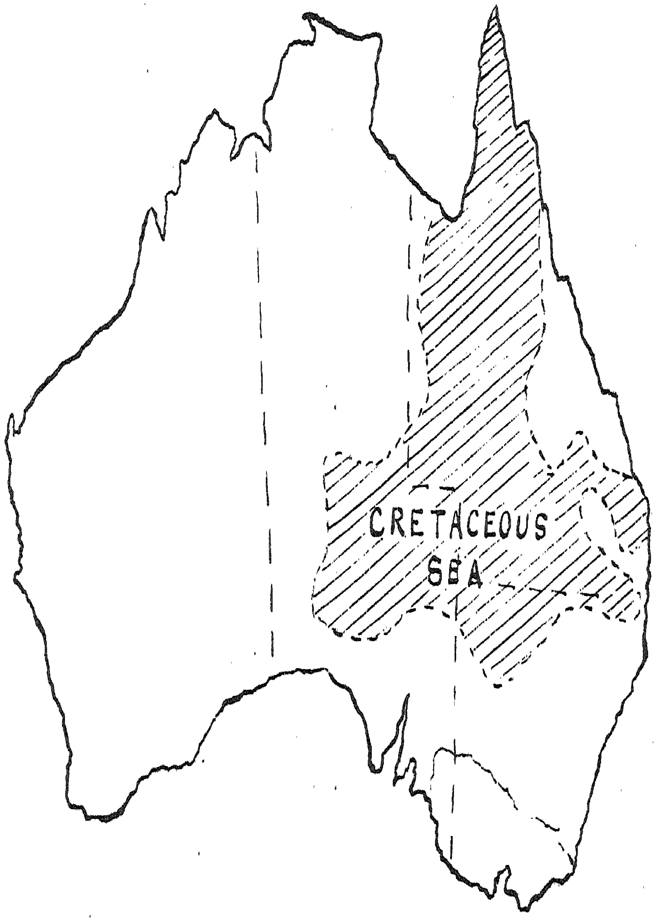


Fig 9.

Distribution of Land and Sea in the Cretaceous.

The Marine Area is Shaded.



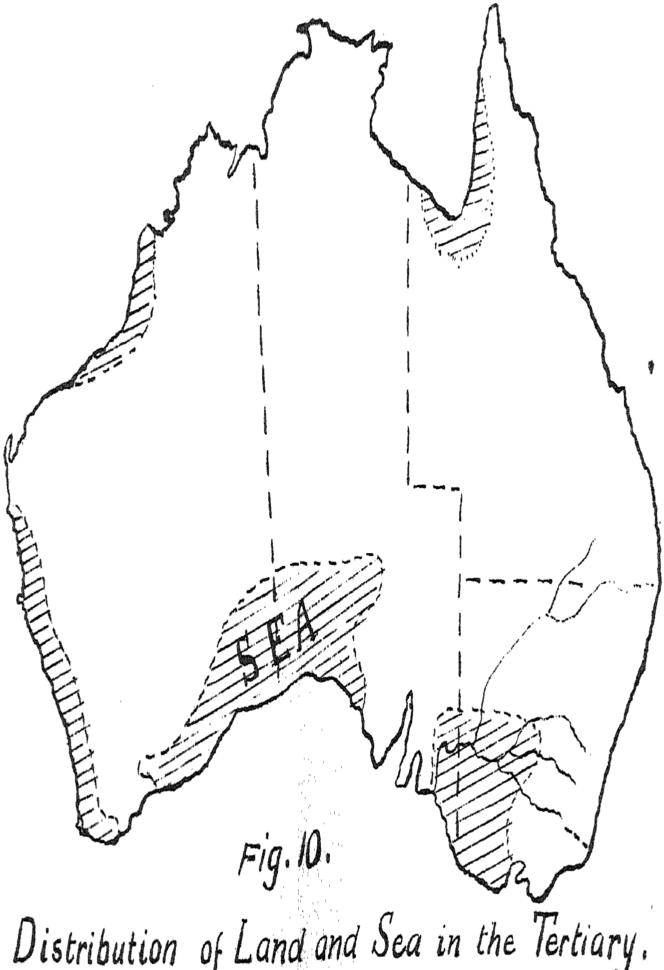
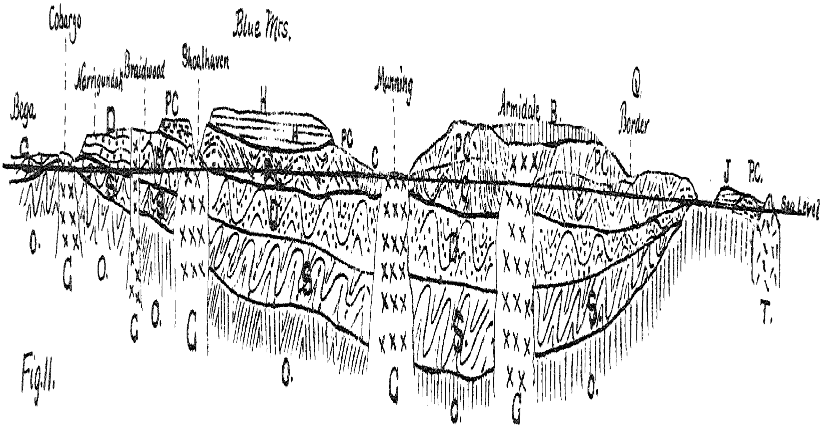


Fig. 10.

Distribution of Land and Sea in the Tertiary.

Land unshaded : Sea crosslined.


Cobargo
Blue Mts.
Narrigundah
Braidwood
Shoalhaven
Bega
Muning
Armidale
Border
Q
B.
D
PC
H
PC
C
PC
PC
J
P.C.
Sea Level
S
S
O.
G
O.
G
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G
D
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Fig. 11.

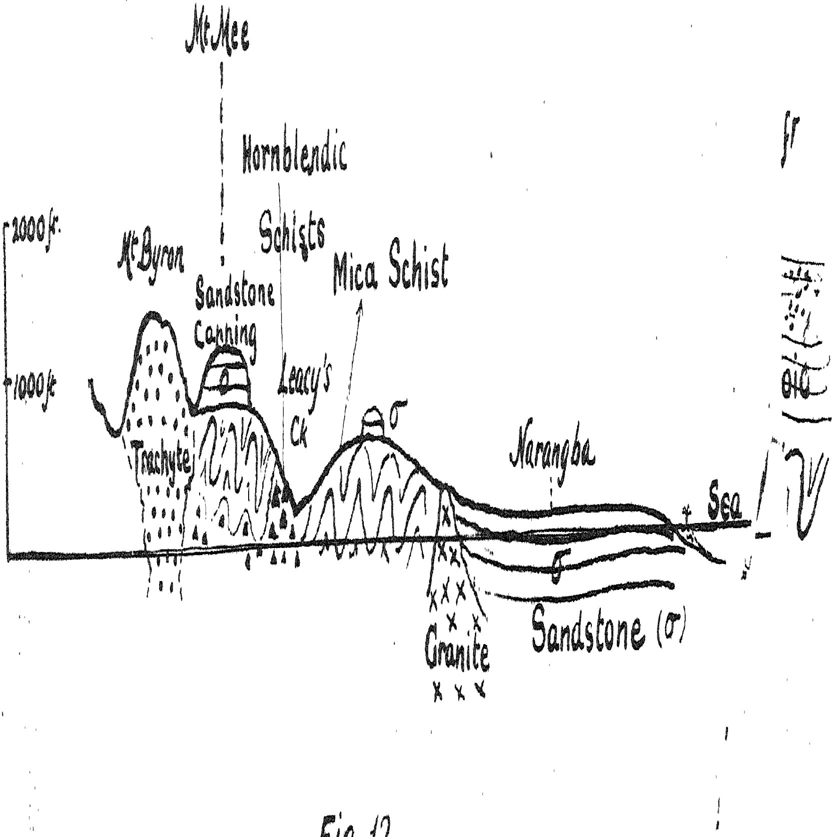
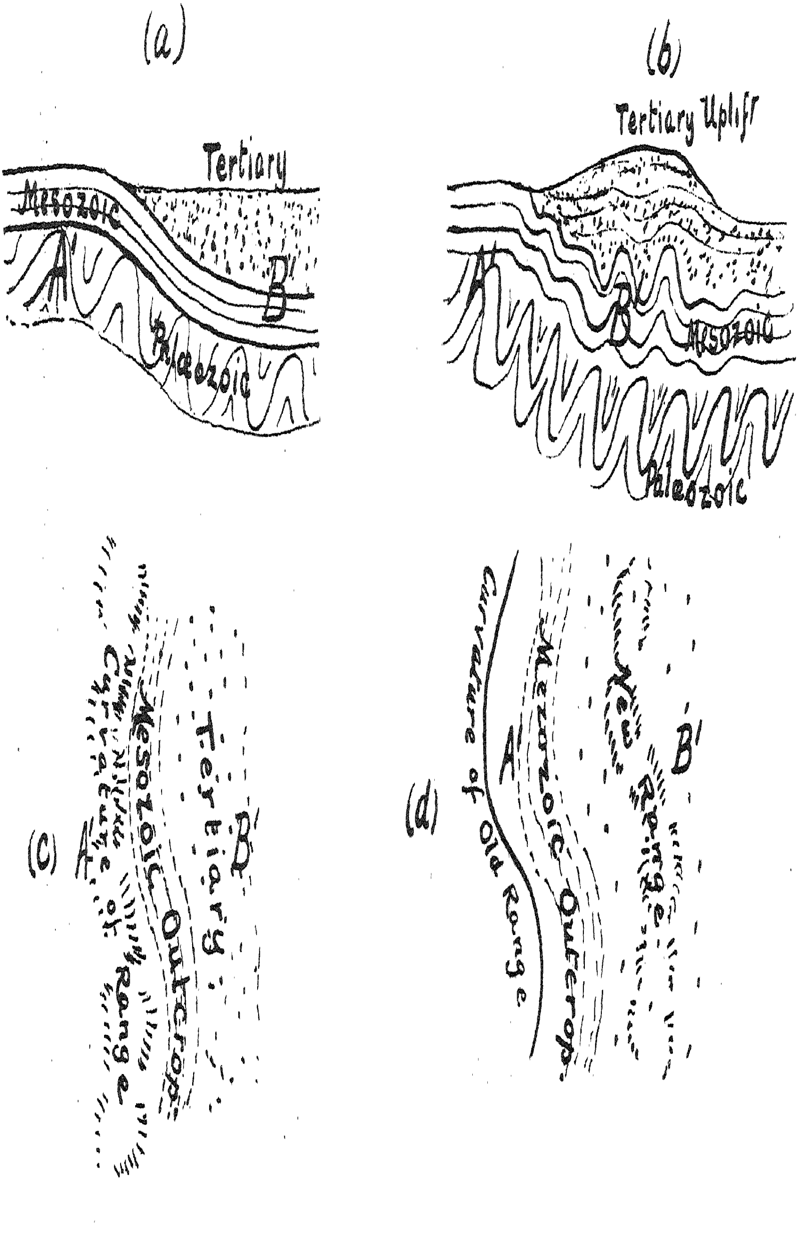


Fig 12

Scale abt. 4m. per inch.

Fig 13.



(a)
Tertiary
Mesozoic
A'
B'
Paleozoic
(b)
Tertiary Uplift
A'
B'
Mesozoic
Paleozoic
(c)
A
B
Curvature of Range
Mesozoic Outcrop
Tertiary
(d)
Curvature of Old Range
A'
Mezozoic Outcrop.
New Range
B'

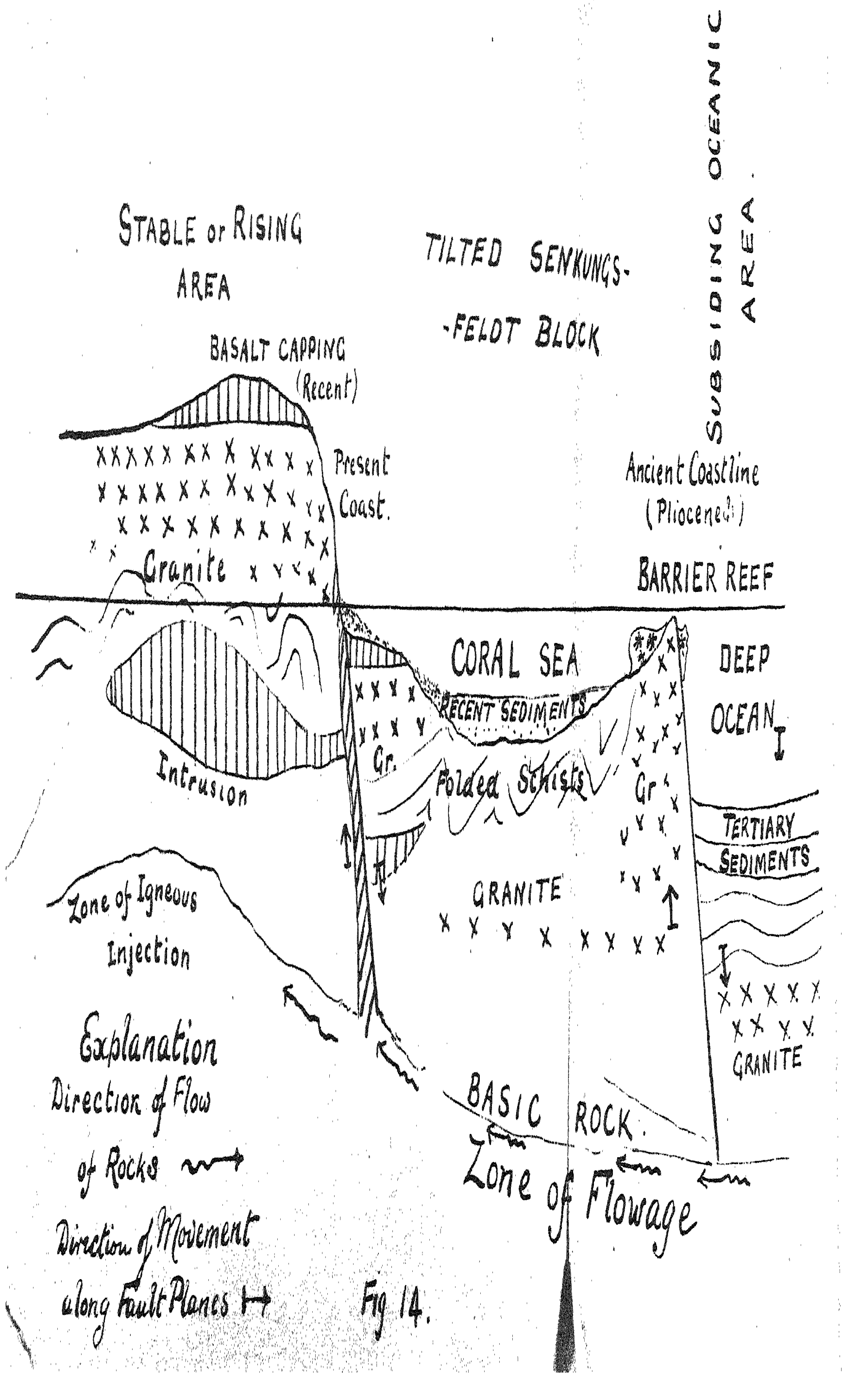

STABLE or RISING AREA
TILTED SENKUNGS-FELDT BLOCK
SUBSIDING OCEANIC AREA
BASALT CAPPING (Recent)
Present Coast.
Ancient Coastline (Pliocene?)
BARRIER REEF
Granite
CORAL SEA
DEEP OCEAN
RECENT SEDIMENTS
Intrusion
Gr.
Folded Schists
Gr
TERTIARY SEDIMENTS
GRANITE
Zone of Igneous Injection
GRANITE
BASIC ROCK.
Zone of Flowage
Explanation
Direction of Flow of Rocks
Direction of Movement along Fault Planes

Fig 14.

And WOOLNOUGH, W. G.
"Important Example of River Captive, in N.S.W."
Proc. Linn. Soc., N.S.W., 1907, Pt. 2. [36].

TENNISON-WOODS.
"The Desert Sandstone."
Proc. Roy. Soc., N.S.W., Vol. XXII., p. 290. [9].

WEARNE, R. A.
Paper read at A.A.A.S. Meeting, 1911. [15].

EXPLANATION OF TEXT FIGURES.

Figs. 1 to 10. Maps of Australia, showing supposed distribution of land and sea during geological time and zones of heavy sedimentation, after T. W. E. David.

Fig. 11. Ideal section from Bega, N.S.W., to Southern Queensland, showing geosyncline under Southern New England up to end of Permo-Carboniferous, and under Sydney and the Blue Mountains after the Permo-Carboniferous; showing also how folding in the Palæozoic Rocks gets more and more intense as we pass from the South of N.S.W. to New England.

O	=	Ordovician	S	=	Silurian
D	=	Devonian	C	=	Carboniferous
P-C	=	Permo-Carb.	H	=	Triassic
J	=	Trias-Jura	B	=	Basalt (Tertiary)
G	=	Granite	T	=	Acid Lavas (Tertiary)

Note the absence of folding in the Post Carboniferous rocks as Queensland is entered.

Fig. 12. Ideal section from Mt. Byron (D'Aguilar Range) to Coast, near Sandgate.

Fig. 13. (*a*, *b*, *c*, *d*). Sketches showing how a new range is moulded on old divides.

(*a*) before folding; (*c*) plan of same;
(*b*) after folding; (*d*) plan of same.

Fig. 14. Section showing subsidence area between N. Queensland Coast and Barrier Reef. This area is now being covered with sediments, and will in the next geological period become elevated into a fold range being squeezed between a subsiding massive and a rising massive.

THE BUILDING STONES OF ST. JOHN'S CATHEDRAL, BRISBANE.

By **HENRY C. RICHARDS, M.Sc.,**
Lecturer in Geology, University of Queensland.

Read before the Royal Society of Queensland, August 26th, 1911.

INTRODUCTION.

HAVING witnessed the growth of this building which is likely to be a prominent feature for a long time in Brisbane, and being somewhat acquainted with the stones used in its construction, the recording of available information would seem to the author to serve a useful purpose.

In the choice of the building stone, its actual mode of weathering in a structure is of first importance, but failing this, the practice of carrying out mechanical and laboratory tests approximating as far as possible the actual conditions is resorted to. While these latter tests are extremely useful, that, under normal conditions, is the real one. Unfortunately, records of the stones used in old buildings are generally unobtainable, thus, much of the information to be obtained from a study of the weathering of the stones in old structures is thereby lost; hence the importance of accurately recording the available information and current opinions as to the stones at the earliest opportunity.

STONES USED IN THE BUILDING.

These have been gathered from three Australian States, although the bulk of the material is of local origin, and both igneous and sedimentary rocks have been used.

Five different stones, of which the following is a list, are contained in the structure :—

Tuff	Locality	Brisbane.
Sandstone	,,	Helidon, Queensland
Sandstone	,,	Sydney.
Granite	,,	Harcourt, Victoria.
Basalt	,,	Footscray, Victoria.

The igneous rocks, namely the Granite and Basalt, have been used in the basement; the main structure is of the Brisbane tuff, which is generally called "porphyry," while the sandstone used outside comes from Pyrmont, Sydney; the inside sandstone being obtained from Helidon.

Description and Some Tests of the Stones.

(1) TUFF.

This is the material familiar to everybody, and which is used for road-metal, coping-stones, pitchers, building material, etc. It is a fine-grained fragmental rock formed by the consolidation of volcanic detritus such as ashes, sand and lapilli. It is a hard compact material, exhibiting a variety of colours, salmon, pink, grey, white, green, purple, etc., which blend well with one another. The colour effects may be well seen on roads built of this material, after a heavy downpour of rain, when a handsome multi-coloured mosaic is produced. Owing to the nature of its texture it does not take a polish, and in the Cathedral is used in medium-sized blocks, either rock-faced or smooth-dressed. It is interesting to note that while tuffs are not generally used for building purposes owing to their porosity and friability, the so-called "peperino" of the campagna of Rome and Naples is a tuff, and has been used in other buildings in those cities, it was also used in the houses of Herculaneum and Pompeii.*

The material in question was obtained from the O'Connelltown quarries, one of the numerous tuff quarries in the immediate neighbourhood of this city. Immense quantities of this excellent material exist, as it occurs bedded up to a great thickness, as shown opposite the Botanic Gardens, and at the Leichhardt Street quarry. It occurs geologically almost at the base of the Tria-Jurassic System, being separated from the much-older underlying schists by a few feet of highly carbonaceous shales, which, in many places, contain abundant traces of fossil trees. The source of the ashes which build up this tuff was in all probability an ancient volcano, of which the present Enoggera granite marks the base.

*Hull, Building and Ornamental Stones. P. 283.

This tuff is not of uniform compactness in all the quarries or even in the same quarry, and requires to be carefully chosen, but when well picked and dressed properly, is found to be a highly durable stone under the local climatic conditions.

(2) HELIDON SANDSTONE.

This stone is also well known in Brisbane, having been used in many structures.

There are several varieties, white, pink, and brown. The Lands Office affords the best instance perhaps of a structure of the brown stone, while in the Central Station buildings, the white and also the pink varieties may be seen. The former building, with the exception of the columns and the stones above them, which are of Yangan material, is of the brown Helidon stone, the basement being of granitic stones from Enoggera and Mount Crosby. The brown variety is a particularly handsome material, works well, occurs in large blocks, and has a warm tone in contrast to the cold, hard effect of the white variety. The concentric markings due to the iron-staining, together with the variation of iron-contents in the different blocks give a structure of this material a very pleasing effect, particularly when compared with buildings of a uniform grey stone, like the Treasury Building.

All the interior work of the Cathedral, the walls, ceiling and pillars, is done with this stone, and an examination of this building shows the possibilities in working this freestone.

Owing to its protection from the weather, not the slightest fear need be felt as to its endurance.

The stone was obtained from Wright's quarry, and the following information on the brown stone used in the Government Printing Office, and now being used in the Central Technical College buildings, has been very kindly supplied by Mr. T. Pye, the Deputy Government Architect:—

COMPRESSION STRENGTH.

	Building.	Lbs. per sq. inch.	Tons per sq. ft.
1.	Government Printing Office ..	5355	344.25
2.	Central Technical College ..	5076	326
3.	Central Technical College ..	3624	233

Numbers 1 and 2 were dry, while 3 was wet.

THE SPECIFIC GRAVITY.

The specific gravity of the stone used in the Government Printing Office was 2·337, and the *absorption* by weight 4·41 %, giving a *bulk absorption* of 10·30 %.

Subjected to *acid tests*, the stone, after being immersed in a solution containing $2\frac{1}{2}$ % hydrochloric and $2\frac{1}{2}$ % sulphuric acids for 48 hours' was quite friable after the treatment.

Chemically, the stone is stable, and contains a medium silica percentage, while the loss on ignition and ferric oxide values are higher, the latter one would expect from the colour of the stone ; lime and magnesia are absent or present in slight traces only.

The above results carried out for the Public Works Department on the brown stone obtained from Wright's quarry for the Government Printing Office now being erected, might be taken in a general way to hold for the brown stone from Wright's quarry in the Cathedral just completed.

The compression test is a fair one for sandstones, and gives a value more than sufficient for the purposes to which the material is put, being approximately the same as the Sydney stone.

The absorption value is medium, but in a climate like Brisbane enjoys, and which is for building stone purposes free from frost, it does not matter to any great extent, more especially as the atmosphere of this city is not laden with acids, and the stone shows no traces of carbonates.

The chemical constitution and acid test call for little comment.

Reviewing the above tests, this stone for building purposes must be regarded as a very fair building material in comparison with other Australian sandstones.

(3) SYDNEY SANDSTONE.

This is one of the widely-used Sydney freestones, and is obtained from the Pyrmont quarries, being known there as the Purgatory stone. It is hard, according to masons, as hard as its name, and has given evidence of its weathering qualities in Sydney, where the conditions are perhaps somewhat more severe than here. Its chief objection has been the manner in which it frets in certain

situations, this being due in the opinion of Messrs. Vernon and Kent to a perishing of the cementing medium of the quartz particles, a kind of dry rot, and which only appears to occur when the stone is not exposed to the moisture of the atmosphere.*

The variety used here is grey-coloured, though occasional blocks of the brown variety have been employed, and these arranged somewhat haphazardly produce an effect which serves to break what would otherwise be a somewhat monotonous dull-grey colour. An examination of the stone work around the beautiful window on the N.E. side of the building shows the manner in which this material lends itself to carving.

Views have been expressed to the effect that the Helidon stone might, with more advantage, have been used for the external purposes to which the Sydney freestone has been put.

The former, from a colour effect, may have been more pleasing, but its weathering qualities for this type of work have yet to be fully demonstrated. The brown variety of Sydney stone, such as has been recently used in the New Zealand Life Assurance building, in Queen Street, is peculiar, owing to its taking on the familiar soft brown colour after being exposed for some time. This is due to the fact that the stone when freshly quarried contains a small amount of ferrous iron, sometimes in the form of carbonate, which becomes oxidised to the ferric state on exposure.

Owing to the somewhat uneven distribution of the ferrous iron contents, the stone does not become a uniform brown, which is rather fortunate from an architectural point of view.

The following tests of the Sydney stone will be of interest. Those with an asterisk are taken from the paper published by Nangle and Baker, in Proc. Roy. Soc., N.S.W., Vol. XLIII., while the others were carried out by the author, and published in "The Building Stones of Victoria," in Proc. Roy. Soc, Vic., Vol. XXII.

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*R. T. Baker and J. Nangle, Proc. R.S. of N.S.W., Vol. XLIII., p. 189.

Compression Tests.

Edge of Cube.			Lbs. per sq. inch.	Tons per sq. foot
3 inches ..	..	..	4800	308·5
3 inches ..	..	..	4861	312·5*
3 inches ..	..	..	5645	366·9*
3 inches ..	..	..	5747	370·1*

Absorption Test.

This gave a value of 3·65 % by weight and 8·40 % by bulk, which, in comparison with other sandstones, is fair.

Attack by Carbon Dioxide.

To ascertain this a current of carbon dioxide gas was passed continually for 3 weeks through water containing the stones in two-inch cubes, and as a result, 0·03% by weight was lost; this is an excellent result.

Attack by Mineral Acids.

Two-inch cubes were placed in solutions containing 1 % hydrochloric and 1 % sulphuric acid, and allowed to remain in it for 96 hours. As a result of this 1·031 % by weight was lost, and a decided darkening in colour was produced; this value is rather high.

Specific Gravity.

The specific gravity of this stone is about 2·30, and thus has a weight per cubic foot of approximately 144lbs., a medium weight for a sandstone.

Fire Test.*

The stone, after being subjected to a temperature of 750° C. for 15 minutes was plunged suddenly into cold water and was uninjured, no chipping at the edges, but merely a deepening in colour due to further oxidation of the iron contents.

The above results, together with its observed mode of weathering, point to the stone being quite a satisfactory one for the purpose it is asked to serve in this building.

(4) Harcourt Granite.

This has been used very extensively in Melbourne and other parts of Victoria. It is distinctly handsome when polished, though in this building being used in the foundations it is not polished.

This is a somewhat coarse-grained grey granite, which is made up of quartz, felspar, and the black mica biotite, the latter being in abundance and sufficiently fresh to show

up well in contrast to the milky-white felspar and colourless quartz. It has proved its stability as a building stone, and a notable example of its use and weathering is to be seen in the Equitable Buildings, Collins Street, Melbourne. It is a stone that works with ease in all directions, can be obtained in very large blocks, and quarries well ; the quarries being in close proximity to the railway line at Harcourt, it can be delivered in Melbourne at a very reasonable rate.

The local granite from Enoggera must be regarded as an inferior stone in many ways, but owing to its containing hornblende, as far as strength is concerned it probably surpasses the Harcourt material, but this mineral also greatly increases the cost of working. The Enoggera stone is rather fine in texture, has not the same relief when polished, and is liable to contain crystals of pyrites and vughs of calcite. These two latter minerals weather rapidly, especially the former, which becomes oxidised, and a dirty brown patch is formed. This phenomenon may be well seen in many of the stones used in the base of the Lands Office. Compression tests on three-inch cubes of Harcourt Granite have given the following results :

Stone.	Lbs. per sq. inch.	Tons per sq. foot.
Harcourt granite	11,444	736
Harcourt granite	11,333	729

Being an igneous rock it is almost impervious, and all its minerals are of a very stable nature, there being no carbonates or sulphides, while the black mica is found to stand weathering excellently. The climatic conditions likely to affect the stone are those of extreme temperature, but in this city no fear need be anticipated on that score.

(5) Footscray Basalt.

This is the familiar bluestone used in Melbourne for many varied purposes, of which the uses for building stones, copying stones, pitchers, and road metal, are the chief ones. It is a dark compact basalt which works easily and as a result of its proximity to the city in suitable masses is cheap.

Owing to its igneous nature and its chemical constitution, it is an excellent weathering material, but buildings of this stone alone are objected to on account of its sombreness, though for bulk stores and gaol structures it gives an air of great solidity. It is chiefly used as a

building stone for basements, a favourite combination being sandstone as a super-structure on basalt, with which very handsome results are obtained.

While not in much evidence in the now completed Cathedral, it has been used in parts of the foundations of this building, and, as far as durability and strength are concerned, it has fully proved itself under more severe conditions than exist here.

St. Patrick's Cathedral in Melbourne is built almost entirely of this stone, with the result that it will long outlive St. Paul's Cathedral, which is built of the Geelong freestone and Waurn Ponds limestone, both of which stones have already very much decayed. The crushing strength of this material on a three-inch cube was found to be 10,577lbs. per square inch, or 680 tons per square foot, a strength more than sufficient for its use in this building.

Conclusions.

From the foregoing it will be seen that of the stones in the Cathedral, the Harcourt Granite and Footscray basalt used in the basement are stones of proven quality, and no doubt need be felt of their lasting properties.

The inside Helidon sandstone, owing to its compression strength, its protection from the weather and its lasting properties even when exposed, also promises a very long existence.

The outside materials, namely, the local tuff and the Sydney freestone will determine the life of the building; of these the tuff from its texture and composition and apparently wise choice should weather excellently, whereas if any stones show signs of decay one would expect them to be the Sydney sandstone in exposed conditions, where it is finally carved, and the smooth-dressed tuff. The former will, in the course of time, almost certainly fret in places, as it has done in Sydney buildings, and being smooth-dressed might be expected to exfoliate in other places, that is, thin flakes a fraction of an inch thick, part from the rest of the stone in a direction parallel to the surface, as a result of the disturbances produced by the uniform tapping over the face of the stone during dressing.

In conclusion, I would like to extend my thanks to Archbishop Donaldson, Mr. R. S. Dods, and Mr. T. Pye, for information afforded me in connection with this paper.

ON THE OCCURRENCE OF "WORM-NODULES" IN CATTLE—A SUMMARY.

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FOR the past two years a considerable amount of attention has been paid, both in the Commonwealth and in Europe, to the occurrence of "worm-nests" or "worm-nodules" in cattle in various parts of the world, but more particularly in Australia. Since these nodules are known to be common and widespread in this state (Queensland), which is an important meat-producing country, and since their presence is causing heavy financial losses to pastoralists and meat exporters, I have deemed it advisable to bring together for public information, a summary of what is known regarding this parasitic condition. As "worm-nodules" may be produced in man, camels, horses, etc., by allied parasites (*Onchocerca*, spp.), casual reference is made to them also. The following account refers to that form of Onchocerciasis met with in Australian cattle :—

Macroscopic appearance :—The naked-eye appearance has been described fully by various authors (Gibson, Park, Cleland and Johnston, Leiper, Gilruth and Sweet), so that only brief mention need be given here. The nodules vary in diameter, from under two to four centimetres in the case of approximately spherical forms, while others of an elongate shape may possess a long axis, measuring 7 cms., or even greater. Gilruth and Sweet (1911, p. 7) found one reaching 11 cms. by 8 cms., whilst, very rarely, they meet with others so small that their diameter was only six millimetres. On cutting across a nodule, one notices that the "worm-area" lies at or near the centre, though occasionally quite eccentrically. There is very little variation in the size of this area though the thickness of the surround-

ing fibrous capsule may vary greatly in different nodules. The parasite, *Onchocerca gibsoni*, Cleland and Johnston, lies coiled in the worm area in such an intricate manner that it is impossible to extract the female entire. The small male worms may occasionally be obtained in an unbroken state. These nematodes are seen to lie in a definite tunnel or canal, within which they appear to be capable of a slight movement. Gilruth and Sweet (1911, p. 10, figs. 3, 4, 37) have figured a tunnel in which the male and female worms are lying side by side. The actual nodules are, of course, the result of irritation of the surrounding cells of the host-tissue, set up by the presence of the parasite. An eosinophilia is also present. When the worms dies, it degenerates, becoming calcified and finally breaking down, the worm area undergoing a degeneration also. This condition is more frequently met with in older animals. The statements that tuberculosis is commonly associated with this alteration are not substantiated.

Seat of infection, etc.:—The commonest situations in which the parasite occurs are the brisket and flank, between whose muscles and in whose subcutaneous tissues the worm-nodules lie. The affected areas have been defined as follows:—(Gilruth and Sweet, 1911, p. 5, 6.) "The commonest situation is the region of the brisket, chiefly the triangular outline formed by the junction of the ribs with the costal cartilages, especially between the fourth and sixth ribs, but often extending backwards to the tenth, and, at times, forward to the second rib. Frequently they are superficial, *i.e.*, in the subcutaneous tissues, but more often they are situated between the posterior portion of the superficial pectoral muscle and the anterior part of the posterior deep pectoral, between the posterior portion of the deep pectoral and the external abdominal oblique, and between the panniculus and the posterior portion of the external oblique, rarely deeper. . . The other situation is the external surface of the hindlimb, especially behind the femoro-tibial joint, and the groove leading upward to the pelvis, anterior to the gluteus maximus, and even near the angle of the haunch. While occasionally superficial and readily detected, they are often under the dense subcutaneous fascia lata, when they are much more liable to be overlooked." They mention the

reported occurrence of nodules in other situations, such as "on the inner side of the thigh, in the groin and even throughout the body," but they are "strongly inclined to the opinion that such conclusions have resulted from small tumours of different origin being mistaken for these nodules." Dodd (1910, *a*, p. 86) mentioned that they may occur in the connective tissues in any part of the body. We found them mainly in the brisket (C. and J., 1910, *c*, p. 92), but referred to their presence in certain other situations. Dr. Cleland and myself have seen an encapsuled specimen, said to have been taken from the neighbourhood of the spleen, a situation similar to that from which *Filaria lienalis* was recorded by Stiles.

In regard to the number which may be found in an animal, we (Cl. and J., 1910, *c*, p. 92) have recorded the finding of twenty-one in the brisket alone. As many as fifty has been counted from one host (Gilruth and Sweet, p. 6.), while a yearling (p. 4) was found to harbour twenty-four. Gibson (1893, p. 577) mentioned that he had been informed by butchers that, in rare instances, nodules were so numerous and so distributed in an animal, that condemnation of the whole carcase was necessary.

Age incidence :—As a result of careful ante- and post-mortem examinations of a large number of cows and bullocks of various ages, Gilruth (p. 4, 5) found that there was a heavy infection in the case of yearlings, as in old animals, and that one sex was as liable to become parasitised as the other, but that in the older animals there was usually a greater percentage of degenerated nodules. The youngest animal recorded as having been found to be infected was between six and seven months old (C. and J., 1910, *c*, p. 92; six to eight months—G. and S., 1911, p. 5). This is conclusive evidence that the worm can mature very rapidly, and also suggests that the life of the parasite probably does not extend over many years.

Degree of infection :—The most important statements regarding the degree of infection are those of Gilruth (1911, p. 3), who has had opportunities of investigating this side of the question. He states that "so far as could be ascertained, no cattle station in Queensland is entirely free from the parasite," that at least twenty per cent. of animals on "clean" stations are affected, and that a complete

examination would possibly show that fifty per cent. is a nearer approximation. He instances a case in which ten per cent. were found to be infected after "very careful examination by manipulation, using incision only when certain or doubtful, but later on, when the brisket of a number were partially dissected, another 25 per cent. were found to harbour the nodules." Thus 35 per cent. of the cattle, from a "notoriously clean station," from the south-western portion of Queensland, were parasitised by *Onchocerca gibsoni*. In two mobs, from different parts of north-western Queensland, the same observer detected their presence in 60 per cent. of the animals "without any manipulation," and as a result of "a more careful examination by dissection," found *every* animal to contain "from one nodule upwards." It is known that the heaviest infection occur in the more northerly districts, and that the degree lessens as we pass southward. Gilruth and Sweet believe that this state of affairs is not due to the conditions of "soil, climate, rainfall or management." Gibson (1893, p. 577) mentioned that he had been informed by Mr. Stanley, the New South Wales Government Veterinarian, that at least 50 per cent. of the cattle slaughtered about that time (1892) in Sydney, contained worm-nests, but Gilruth and Sweet (p. 3) doubt this large percentage. Our own experience did not reveal such a high degree of infection. Hancock (1911, p. 25) states that "since examination has been systematically made, at least 50 per cent. of all consignments from Queensland ports have been found to contain a variable percentage of affected carcases." Judging from Gilruth and Sweet's findings, Hancock's estimate would be greatly increased if a more searching examination were carried out. The Editor of the *British Medical Journal* (3rd Dec., 1910, p. 1797), mentioned that about 75 per cent. of the carcases were found to be parasitised. Macfadden's findings (1911, p. 2) corroborate those of Gilruth. He stated that at first ten per cent. of the quarters in each consignment mere examined for the presence of nodules, but on a more complete examination, it was noticed that a much larger percentage was infected, and in some instances "as many as a hundred per cent. of those already passed" were found to contain worm nests. The Editor of the *Journal of Meat and Milk Hygiene* (1911, p. 23), in a footnote to our paper

(Cleland and Johnston, 1911, *a*, p. 21-23), refers to the fact that "in one consignment of 1,500 hind quarters which recently arrived in London, 808 were found to be infected." This is about 54 per cent., and the number would probably have been greater had fore-quarters been examined. If we consider what a large amount of meat is exported from Australia, especially Eastern Australia, to Great Britain and elsewhere, we must realise the seriousness of this parasitic invasion. Macfadden (1911, p. 3) states that between 60,000 and 70,000 quarters of Australian beef arrived per month, between July and October of last year (1910) at the port of London alone.

Effect on host:—In regard to the result of this parasitism on the health of the infested animal, it is of importance to note that no authors, excepting Barnard and Park (1894), have mentioned any deleterious effect produced by the presence of the *Onchocerca*. In reference to the statements made by these authors, we (Cleland and Johnston, 1910, *c*, p. 93) have already suggested that tubercular and actinomycotic tissues, from various parts of the body, had been inadvertently mixed with true worm nodules, and hence their mistake in believing that tubercle commonly follows the parasite. Dodd (1910, *a*, p. 86), Hancock (1911, p.25), Nicoll (1911, p. 73), Gilruth and Sweet (1911, p. vii) and others agree with us in our assertion that the presence of the nematode is not any in way detrimental to the host.

Public health aspect:—From the point of view of public health and meat inspection, we must admit that the presence of animal parasites in food is undesirable. We think that they should be removed, but even if eaten, whether unconsciously or otherwise, as already pointed out by us (1910, *a*, p. 174; 1910, *c*, p. 98), no harm would result. Dr. Gibson (1893, p. 579) fed a dog on worm-nests for a considerable time without ill effect. Then again, the parasite can only survive the death of the host for a very short time. The same remark applies to the embryos. Besides this, there is no possibility of direct transmission through eating, even if the same species were able to live in man which is most improbable.

Robinson (1910, p. 6) reported that Dr. Collingbridge, the Medical Officer of Health for London, had stated that

"the portions of meat containing the parasite are obviously unfit for food and should be destroyed." We do not agree with this remark. The meat in unaffected, though the connective tissue immediately surrounding the worm is affected, since the formation of a dense fibrous capsule or "worm nodule" is the result, but the effect does not extend beyond this. The Editor of the *British Medical Journal* (3rd Dec., 1910, p. 1797) mentioned "that the meat in question is little, if at all, deteriorated in quality, that it is perfectly safe for human consumption, and that its unsightly condition may be remedied by the removal of the nodules." Nicoll (1911, p. 73) says, that "there is no evidence to show that the meat suffers, or that it is dangerous for human consumption, and the fact that is has been eaten for some time, both in this country and in Australia, without ill consequences being remarked, may be taken to support the Australian view."

Distribution in Australia:—The greatest percentage of infection appears to occur in Queensland, especially in the more northerly and westerly regions, and as one passes southwards, the condition becomes less common. Though occurring in New South Wales, its presence is more or less restricted to the Northern Rivers and the Hunter districts, though it may be found occasionally in cattle elsewhere. It is difficult, however, to trace the origin of cattle brought in for slaughter, but a large percentage come "overland" from Queensland to Sydney, Melbourne and elsewhere. Hence at the abattoirs in these cities and in Hobart, nodules are met with. The occurrence of the condition in Victorian-bred cattle is doubtful, while Tasmania appears to be free from it. It is well-known in Western Australia and in the Northern Territory. The distribution outside of Australia will be referred to in another place.

The parasite:—The main papers dealing with the parasite (*Onchocerca gibsoni*) infesting Australian cattle are those of Cleland and Johnston (1910, 1911), Leiper (1911), and Gilruth and Sweet (1911). The worm had usually been referred to as *Spiroptera reticulata*, which is a parasite infesting horses in Southern Europe. Barnard and Park (1894, p. 644), Park (1893, also in Tryon, 1910),

Shipley * (1910), and Hancock (1911, p. 25) refer to it under that name; Leiper* (1910), as *Onchocerca reticulata*; Bancroft (1893), as *Strongylurus* sp.; Cleland (1907, p. 88), and Johnston (1909, p. 412), as *Spiroptera* sp.; and Tryon (1910, p. 81), as *Spiroptera* (*Onchocerca*) sp.; while Cleland and Johnston, a little later (1910, *a*, p. 174) described it as a new species of Filaria, *F. gibsoni*. Later in the same year (1910, *c*, p. 96), they removed it to the genus *Onchocerca*. Later authors (Leiper, 1911; Nicoll, 1911; Gilruth and Sweet, 1911), have followed them in calling it *O. gibsoni*. The synonymy of the nematode may be summarised thus :—

Onchocerca gibsoni (C. and J., 1910, *a*), Cleland and Johnston (1091, *c*).
? *Filaria lienalis*, Stiles, 1892 (undescribed).
Spiroptera reticulata, Park, 1893, Bernard and Park, 1893; Shipley, 1910, etc. (*nec.*, Diesing, 1841).
Strongylurus sp., Bancroft, 1893.
Spiroptera sp., Cleland, 1907, Johnston, 1909.
Filaria gibsoni, Cleland and Johnston, 1910 *a*.
Spiroptera (*Onchocerca*) sp., Tryon, 1910.
Onchocerca reticulata, Leiper, 1910 (*nec.* Diesing).
Filaria (*Onchocerca*) *gibsoni*, Clel. and Johnston, 1910, *d*.
Onchocerca gibsoni, Clel. and Johnston, 1910, *c*; Leiper, 1911, etc.

Onchocerca reticulata, Diesing, known more commonly but less correctly, as *Spiroptera reticulata*, is a distinct, but closely allied, parasite infesting the horse, and is known under various synonyms, *e.g.*: *Filari reticulata*, *F. cincinnata* and *Spiroptera cincinnata*. *F. lienalis*, Stiles, may be a synonym of *O. gibsoni*, and is evidently an *Onchocerca*, as Leiper (1911, *a*, p. 10) has suggested. Its specific identity with the Australian worm seems to me to be unlikely. The main distinctions between *O. gibsoni* and *O. reticulata* have been tabulated by Leiper (1911, *a*; p. 10).

The original account (1910, *a*) contains a few inaccuracies regarding the male worm, but these were corrected and a more detailed description of the male, female and embyro was given in a larger report published some months later. (August, 1910, *c*.) Gilruth and Sweet have shown recently (1911), that there is a considerable amount of

* Quoted in an abstract of a report (1910)—Editor *Jour. Meat and Milk Hygiene*, 1911, p. 24.

variation in the mature parasites. The following summary is taken mainly from the papers just referred to :—

The female is very long, but its exact length is unknown, owing to the impossibility of extracting it entire. By adding the lengths of all the fragments collected from a single nodule, apparently containing only one parasite, we (1910, *c*) found measurement to be 97 cm., while Gilruth and Sweet found it to vary from 52 to 140 cms. The cuticular ornamentation is in the form of series of spirally arranged ridges, each ridge being made up of a series of undulations. The anterior end is bluntly rounded, bearing a tiny papilla on each of the three small lips which surround the mouth. The diameter in the anterior part of the worm is from ·08 to ·16 mm., and throughout the greater part of the body is from ·37 to ·5 mm. The vulva varies in its position, being situated between ·46 and 1·23 mm. from the anterior extremity. The nerve-ring lies at from ·142 to .188 mm., and the excretory pore at from ·36 to ·38 mm. from the head end. The anus is located at about ·20 mm. from the posterior extremity.

The male is a very thin and relatively short worm with much less pronounced cuticular ornamentation. It is scarcely half the width of the female and its length varies between 3·75 and 5·3 cm. (Leiper; Gilruth and Sweet.) It is thus approximately only about one-twentieth of the length of its partner. The nerve-ring is situated at from ·17 to ·2 mm., and the excretory pore at ·25 mm. from the anterior end. The cloaca lies at a distance of from ·048 to ·072 mm. from the posterior extremity.* The two spicules are unequal. The longer is from ·14 to ·197 mm., and is a curved rod with a twisted stem and a pointed distal termination. The smaller spicule is swollen characteristically at the outer end. Its length varies from ·08 to ·094 mm. There are six, probably seven, pairs of pipallæ on the tail end of the male. There is a peri-anal group, consisting of four pair, and a caudal group of two pair. At the extreme end there is a pair of minute projections, which probably represents the seventh pair.

* In our paper (1910, *c*, p. 94) the distance in one case is given as ·072, and in another ·65 mm. The latter is a misprint for ·065 mm. In our preliminary report (1910, *a*), the length of the smaller spicule was given as ·047, instead of ·082 mm., and some of the papillæ were overlooked.

In the peri-anal group, the first pair are usually slightly more prominent and somewhat separated from the remaining three pair, which are really ad-anal or post-anal in position, the first pair being distinctly pre-anal. Gilruth and Sweet (p. 15) have noted a certain amount of variation in the arrangement. The alae are not very prominent. The tail end has a spiral twist, similar to that recorded as occurring in *O. volvulus*. (Parsons, 1909, p. 363.)

The embryos measures from ·22 to ·35 mm. in length by ·003 mm. in width, the anterior end being obtusely rounded or nearly straight, and the posterior extremity tapering. Gilruth and Sweet have estimated that there may at one time be as many as two million embryos and fertilised eggs in one female.

The internal anatomy of the parasite does not call for attention in this paper. (Cleland and Johnston; Leiper; De Does; Gilruth and Sweet.)

Transmission:—From the economic point of view, the most important feature is the means of transmission. If this be known, then one may hope to be able to formulate measures to limit the degree of infection, by reducing the numbers of the transmitting agents, as is now being done in the case of mosquito destruction in order to lessen malarial and other mosquito-borne infections. Direct transmission of a filarial worm is quite unlikely. We (1910, *c*, p. 98), as well as Gilruth and Sweet (1911, p. 26), failed to inoculate calves by injecting living embryos subcutaneously. An intermediate host appears to be necessary. In some few cases it is known to be a crustacean inhabitating fresh water, but more frequently it is a blood-sucking insect, usually a mosquito. The latter method of transmission presupposes the presence of filarial embryos in the blood of the final or definitive host. But, as yet, these have not been found in the general circulation of cattle affected with *Onchocerca*, nor in horses harbouring *O. reticulata*, nor in men infested with *O. volvulus*. In the case of man, filarial embryos belonging to other *Filariidae* may be met with in the blood, but in cases of an infection by *O. volvulus* alone, such larval forms have not yet been detected. We have given a summary of our results (1910, *c*, p. 97), which were all negative, embryos being found in the peripheral parts of the tumours,

but not in the blood, though searched for in films taken by night as well as by day, in case there should be any periodicity. Since the nodules are practically restricted to those portions of the animal which come in contact with the ground, and since they are frequently subcutaceous in situation, we were led to suggest that a fresh water crustacean might act as a transmitting agent in a manner analogous to that known to occur in the human guinea-worm, *Dracunculus medinensis*. Dr. Cleland and myself have not been able, as yet, to infect *Cyclops* and *Daphnia* with the embryos, the latter living only a very short time in water. We have, therefore, been driven back to our first idea, that a biting insect or a tick might be the actual transmitter. The lack of material in Sydney, and the pressure of official business, prevented our following up this matter as thoroughly as we wished.

Leiper (1911, *a*, p. 12), arguing from the structure of the embryo, believes the intermediate host to be a biting insect, such as *Stomoxys*, *Hippobosca* or *Tabanus*, or perhaps one of the *Ixodidae*. The *Hippoboscidae* may be excluded on account of their absence or rarity on our cattle. *Stomoxys calcitrans* is a common fly in parts of Eastern Australia, and may be responsible for the transmission, but this seems rather unlikely on account of the relatively slow, southward extension of the condition. The same remark applies to the *Tabanidae*. Gilruth and Sweet (p. 27) are not in favour of the idea that biting flies spread the parasite, for the same reason, nor do they think that ticks are responsible, as they state that the nodules were observed long before the advent of the tick in Queensland. They evidently refer to the "cattle tick" *Margaropus* (or *Boophilus*) *annulatus*, var. *australis*, but there are many other ticks which are known to infest cattle in Australia, *e.g.*, *Amblyomma*, *Haemaphysalis*, *Aponomma*, and *Rhipicephalus*, while an *Ixodes*, (*I. holocyclus*) attacks various animals here. None of these, excepting *M. annulatus* are, however, common on cattle, and may be disregarded for the present on that account. The calf louse (*Haematopinus vituli*, L.), is regarded by these workers (p. 28) as being the most likely transmitting agent, and point to certain facts which seem to them to support their contention, viz., that the infection in young and old cattle is about the same; that lice

are frequently present on weakly young animals; that the situation of the nodules is under those parts of the skin which most frequently harbour lice; and that the southward advance is slow. They, moreover, found a living embryo in a louse* which had been fed on an inoculated part of a heifer. It seems to me that the mosquito, the true lice, and the "cattle-fly"—a species of *Musca*, frequently found associated with Queensland cattle—are the most likely agents. The great objection, however, lies in the fact that, as yet, the embryos have not been detected in the blood-stream, and have not been found beyond the nodule.† Even after centrifugalising large quantities of blood, Gilruth and Sweet were unable to detect their presence. In regard to the allied parasite, *O. gutturosa*, from the Algerian cattle, Emery (in Neumann, 1910, p. 271) mentioned that he had not been able to find embryos in the blood.

The life history is not yet known in any species of *Onchocerca*. Brumpt (1904, quoted by Fülleborn, 1908, p. 15), Fülleborn (1908, p. 15), and Rodenwaldt (F. and R., 1908, p. 83), found embryos of *O. volvulus* in the peripheral parts of the tumours from human beings, and the first named author believed that a *Tabanus*, *Glossina* or *Simulium* might act as a transmitter. None of these authors, nor Parsons (p. 366), detected embryos in the blood, but the latter worker states that the distiibution of *O. volvulus* "suggests the existence of a riverine intermediary," and believes it highly probable that embryos must pass sometime in the general circulation (p. 367), the transmitting

* Dr. Cleland and myself have examined a large number of lice (*Haematopinus vituli*, L.) and Mallophaga (*Trichodectes bovis*, L., syn. *Tr. scalaris*, Nitzsch), taken in New South Wales from a young calf infected with nodules, but without result. Of course the Trichodect is not likely to be a normal carrier on account of its food being epidermal structures and not blood. Sometimes blood is found in the crop, but this is not usual, the blood entering from wounds along with the ordinary food.

† Park in a footnote to a paper (Barnard and Park, 1894, p. 645) refers to finding "young *Spiroptera* in some of the blood vessels." Though Dr. Cleland and myself, as well as Professor Gilruth and Dr. Sweet, have worked through series of sections, we have not been able to find embryos in the blood. Park's statement stands quite unconfirmed up to the present as regards Australian cattle. It may be mentioned, however, that De Does (1904) found the embryos in the blood of Javanese cattle, and thought that blood-sucking insects were the most likely transmitting agents.

agent being, by analogy, probably a blood-sucking insect.

We have suggested (C. and J., 1910, *c*, p. 98) that imprisonment within a nodule may not be the normal fate of *O. gibsoni*. Leiper (1911, *a*, p. 13) thinks that an examination of the viscera might reveal the presence of the parasite in an unencapsuled condition, where it would liberate its embryos into the blood stream. On the other hand, one would expect that if encapsulation be abnormal, that there should be a greater number of free than encapsuled parasites, and the detection of the embryos in the circulation should not be difficult. As all the known species of the *Onchocerca* are found more or less embedded in fibrous capsules, and as both males and females may occur together in these nodules, and in such relation to each other that fertilisation is readily effected, (Brumpt, *re O. volvulus*, quoted in Fülleborn, 1908, p. 15, and in Fülleborn and Rodenwaldt, p. 83; Gilruth and Sweet, p. 10, *re O. gibsoni*), it seems to me that the connective tissues, especially the subcutaceous, are *a* normal, and probably *the* normal habitat of the members of the genus.

Origin of the parasite:—The original home of the nematode is almost certainly the East Indies. We (C. and J., 1910, *c*, p. 99) showed that it was probably by way of Timor that infected animals (buffaloes) arrived in Northern Australia. De Does had already recorded the occurrence of worm-nests in cattle in Java, but we were at the time unaware of his work. Gilruth and Sweet (1911, p. 34, addendum) mention that cattle were imported from Coepang, about 1824, and from other parts of the East Indies in 1840. This evidence supports the conjecture that infected animals —either cattle or buffaloes, or both—came from the East Indies to the Northern Territory, and became the means of spreading the condition, which has gradually extended its range southward, eastward and westward.

It might be observed that *O. armillata* (Railliet and Henry, 1910, p. 250) parasitises Indian and Sumatran cattle and buffaloes, and an allied or perhaps identical worm occurs in Malayan and Indian cattle and buffaloes (Daniels, Tuck, Leiper, Lingard). *O. armillata* infests the aortic walls. *O. gutturosa* (Neumann ,1910, p. 270) occurs in the cervical ligament of cattle in Northern Algeria and Tunis. These parasites are distinct from *O. gibsoni*.

Historical Summary:—A brief historical summary has been reserved until now, in order to simplify reference. Only the main papers relating to Onchocerciasis in cattle, more especially in Australian cattle, come in for notice.

The first published record was that by Morris in 1880 (1881, p. 337), though Gilruth and Sweet (1911, p. 1) have been informed that the presence of nodules in the brisket of Queensland cattle has been known for at least forty years. In 1892, Gibson (1893, p. 576) communicated an article to the Intercolonial Medical Congress, in which he gave an account of the embryo and such facts of the female worm as he could extract; of the pathology of the condition; as well as of feeding experiments performed on a dog, but with negative results. In the same year, T. L. Bancroft referred to the presence of nodules in cattle in Brisbane and Rockhampton.

In 1893, Barnard and Park (1894, p. 642) read a short paper, entitled "Notes on *Spiroptera*, associated with Tuberculosis in Cattle," in which they give an account of the result of an enquiry into the condition as affecting Queensland cattle. The parasite was recognised as being similar to *Spiroptera reticulata* (*i.e.*, *O. reticulata*), which infests horses. No cattle under two years of age were found to be affected, and this led them to suggest that the worm probably takes at least a year to develop and cause trouble. They thought that human beings might become parasitised by infected meat or drinking water. The disease was stated to be absent in Tasmania, but probably present in South Australia. A short account of the embryo and of a fragment of an adult was given. "A section of a small tumour or nodule containing the worm has a perforated or reticulated appearance, hence the name *Spiroptera reticulata*" (p. 644). There seems to be little doubt but that various tissues, some tubercular, others actinomycotic, had become mixed with real "worm-fibromata" (as De Does called them), hence the mistake made by these authors in considering that degenerated worm-nests commonly became the seat of tuberculosis or actinomycosis. (C. and J., 1911, *c*, p. 93.)

Similar information was published by Park, in Dec., 1893, in the *Veterinary Journal* (1893, p. 102), and in a report to the Chief Inspector of Stock (quoted in Tryon,

1910, p. 82-4). In the same year, Stanley (1893) referred to the presence of nodules in New South Wales cattle. For many years after this, little notice seems to have been taken of the condition in spite of its commonness. The fact that infected animals apparently do not suffer in health may have been responsible for this indifference towards the matter. The waste of meat incurred in removing the nodules from carcases and in condemning badly-infested portions, should have been sufficient reason for an investigation being undertaken. Apart from a few mere references dealing with the presence of worm-nests in cattle in West Australia (Cleland, 1907), in New South Wales (Johnston, 1909), and in Queensland (Pound, 1909), nothing was done until the latter part of 1909, when Dr. Cleland and myself in Sydney, and Drs. Gilruth and Sweet in Melbourne, began, independently, to devote special attention to the subject. Very shortly afterwards public notice was drawn to presence of these nodules in abundance in frozen carcases arriving from Australia, mainly from this State (Robinson, 1910, p. 6; Ann. Rep. Med. Off. Health, 1909, London, abstract in *Jour. Meat Milk Hyg.*, 1911, p. 24). It was suggested that such infected meat was possibly unfit for human consumption (Collingbridge—quoted by Robinson, 1910, p. 6). This led to severe measures being taken by the Health authorities in London and elsewhere (Robinson, 1910; Hancock, 1910, p. 25; Macfadden, 1911). Of course, a scare was created, and investigations were commenced by the Local Government Board (London). In the Annual Report of the Medical Officer for Health for the Corporation of London for 1909 (1910, p. 106-7)*, it was stated that in November, 1909, a large percentage of carcases of Queensland beef were found to contain encapsuled parasites lying in the connective tissues of the flank and brisket. The nodules, together with a small portion of the surrounding tissues, were removed and the rest passed as being fit for food. In cases where they were very numerous, the whole quarter was condemned. The parasite was identified by Shipley as *Spiroptera reticulata*, and by Leiper as *Onchocerca reticulata*. This report was probably issued early in 1910.

* Abstract in *Journal Meat and Milk Hygiene* I., 1911, p. 24.

Meanwhile a short preliminary paper was published by Dr. Cleland and myself in the February (Feb. 2nd) number of the *N.S.W. Agricultural Gazette*, in which we briefly described the worm as a new species, *Filaria gibsoni*, quite distinct from, though closely allied to, *F. reticulata* of the horse. The idea that the nematode could be in any way injurious to human beings was disputed, as such nodules had frequently been eaten in Australia without any ill-effects having been detected. A more detailed report was reserved for official publication in the Annual Report of the Government Bureau of Microbiology, Sydney, for 1909, which, however, did not appear until August, 1910. This delay allowed the inclusion of some further details, and of information either unpublished or not available at the time of writing the earlier article.

There appeared in the same month (February, 1910), in the *Queensland Agricultural Journal*, two short papers on the subject, one by Tryon (1910, *a*), entitled "Verminous Tumours in Cattle," in which the writer gave a list of Australian literature, and made public some official information contained in reports by Park, and the other by Dodd (1910 *a*), who disagreed with Park's statements regarding the alleged frequent association between these nodules and tuberculosis. About the same time, Railliet and Henry (1910), in Paris, contributed a short paper on the *Onchocerca* group of parasites, and in it referred to the presence of encapsuled nematodes in the connective tissues of oxen having been recorded from Australia (Cleland; Barnard; Park), and from Java (De Does). They also dealt with allied worms causing the formation of worm-nests in other hosts. They discovered that there exists in the horse two species of *Onchocerca*, one *O. reticulata* preferring the legs as its habitat, though found elsewhere; the other, *O. cervicalis*, frequenting the neck. *O. armillata* was described by them as a new species, infesting the aortic walls in oxen and buffaloes in India and Sumatra. Lingard (1905) had already called attention to the presence of aortic worms in Indian cattle. Neumann (1910, p. 270) shortly afterwards described another species, *O. gutturosa*, occurring fairly commonly in the cervical ligament in cattle in Algeria and Tunis. As already mentioned,

the Australian parasite, *O. Gibsoni*, prefers the brisket and flank.

The work of these French parasitologists was not available until after the publication of our official report on "Worm-Nests (Filariasis) in Cattle" (Cleland and Johnston, 1910, *c*). In this article, we reviewed the Australian literature and the public health and pathological aspects of the condition. We also gave a more detailed account of the anatomy of the worm and of its relationship to various other species of *Onchocerca*, such as *O. volvulus*, which causes nodules in man in certain parts of Africa (Fülleborn, Rodenwaldt, Parsons, etc.), and *O. reticulata*, which gives rise to a similar condition in horses (Pader). An account of experiments to determine the mode of transmission was also given. An allied parasite infesting the camel was dealt with incidentally, and was thought to be perhaps identical with *O. gibsoni*. The camel parasite is, however, a distinct species (*O. fasciata*), as Railliet and Henry (1910) have shown. Some of the ground traversed by these authors was also covered by ourselves. Their paper reached us in time to allow us to add a reference to it as an addendum to the above article in its rearranged condition, when it was published in the form of two papers (1910, *d*, 1910, *e*), by the Royal Society of New South Wales.

Early in the present year (1911), a number of papers appeared, the most important being one by Leiper (1911, *a*), an article by Macfadden (1911) accompanying it. Others were published, or rather republished, by the editor of the *Journal of Meat and Milk Hygiene* (Jan. 1911, p. 21-26), while the February number of the same journal contains a brief article by Nicoll (1911).

Macfadden (1911) gave an account of the official method of inspecting the carcases in London, the present inspection being much more detailed and thorough than that detailed by Hancock (1910), as being in force a short time before. He referred to the heavy infection occurring in some shipments, and to the difficulty of coping with large consignments of Australian beef arriving at the port of London.

Leiper's paper (1911, *a*) is a valuable one. In it he deals mainly with the anatomy, geographical distribution, and pathological effects of the parasite. In addition he

makes suggestions regarding the probable life-history, these having been referred to earlier. In regard to the geographical distribution, he refers (p. 10) to an encysted parasite found by Stiles in 1892 in cattle in the United States, and mentioned under the name *Filaria lienalis*, Stiles. A description was not published,* and at a later date (1894), this nematode was regarded as being "*Spiroptera reticulata.*" There is, therefore, little doubt, but that the parasite in question is an *Onchocerca*, perhaps identical with *O. gibsoni*, but I am inclined to believe that it will be found to be a different species, whose normal or original host may have been the bison. Some support for the idea that the two forms may be distinct is derived from the fact that Algerian oxen harbour a different species, *O. gutturosa*, Neumann, and that Indian and East Indian cattle may be parasitised apparently by two species, viz., *O. gibsoni* and *O. armillata*. Ford (1903)† met with one kind—"the aortic worms"—which form nodules in the aortic walls of Malayan buffaloes. These are regarded by Leiper (1911, *a*, p. 10), as belonging to *O. gibsoni*, while Railliet and Henry (1910) describe the aortic worms which infest oxen and buffaloes in India and Sumatra as a distinct form, which they named *O. armillata*. If these species be identical, then the latter will rank as a synonym of *O. gibsoni*, only a few weeks separating their respective dates of publication. They appear to me to be specifically distinct. Tuck (1907, 1908) referred to the aortic worms as well as to another kind—also belonging to the Filariidae—from Indian and Siamese bullocks. From the accounts given, we had regarded both of these as being distinct from *O. gibsoni*. It seems probable that the "aortic worms" (which are not yet recorded from Australia) are *O. armillata*, and that the ordinary "nodule worms" from the brisket and flank are *O. gibsoni*. As already mentioned, *O. gutturosa* is usually restricted to the cervical ligament.

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*In Stiles and Hassall's Index Catalogue of Medical and Veterinary Zoology, part 29, 1910, p. 2266, there is a reference to a paper by Stiles [1892, *q*] "On the presence of *Spiroptera reticulata* in cattle," but mention is made that the MS. was lost in the mail. The paper is, therefore, unpublished.

† Lingard (1905) recorded their presence in Indian cattle.

Leiper (p. 7) does not definitely group all the *Onchocerca* worms producing nodules in cattle under one species. He confines himself to stating that " this parasitic condition is known to occur not only in Australia, but also in the United States (Curtice; Stiles), in the Malay States (Daniels; Ford), and in India (Lingard)."

De Does (1904), Dood and Ouwehand* recorded the occurrence of worm-nodules (worm-fibromata) in Javanese cattle.

In Nicoll's article (1911), there is a brief summary regarding the parasite and the method of inspection of meat in England in order to detect its presence.

Quite recently an important paper by Gilruth and Sweet (1911), entitled "*Onchocerca gibsoni*, the cause of Worm Nodules in Australian Cattle," has been published along with the greater part of our report (C. and J., 1910, *c*, *d*, *e*) by the Commonwealth Government. The work of these authors has been frequently alluded to in the present article. They corroborate our findings generally, and give additional information regarding the anatomy of the worm and the variation met with in the parasites, as well as the early developmental stages of the embryos. Their suggestion that lice may act as transmitters has been already referred to.

The Report of the Agent-General for Queensland in London, 1910, has just been published (Robinson, Sept., 1911), and in it he again refers to the question of nodules in beef, mainly from the commercial side. A brief article will shortly appear in the *Queensland Agricultural Journal* (Johnston, 1911, *b*). There is also a brief reference made by Tryon (1911), in the Annual Report of the Agricultural Department, Queensland (1910-1911).

In concluding this summary, one must emphasise the fact that we need more definite knowledge regarding the means of transmission of the worm. "The elucidation of the life-history of the parasite is the most important part of the investigation of the disease. Until this is effected, no certain preventive measures can be framed or put into force." (Nicoll, 1911).

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* The articles by Ouwehand and Dood (mentioned by Neumann, 1910) are unknown to me.

BIBLIOGRAPHY OF ONCHOCERCIASIS.

NOTE.—I have not been able to consult works marked with an asterisk.

Bancroft, T. L.—

1983. "Notes on Some Diseases in Stock in Queensland," in Report of Chief Inspector, 1892 (1893), Appendix, p. 4.

Barnard, C. E. and Park, A.—

1894—"Notes on Spiroptera associated with Tuberculosis in Cattle." Report Austr. Assoc. Adv. Sci., V., 1893 (1894), p. 642-5.

Braun, M.—

1908. "Die tierische Parasiten des Menschen," 1908 Edition. Also English Translation of Earlier Edition.

Brumpt, E.—

*1904. "Apropos de la *Filaria volvulus*, Leuckt." Revue de Medic et d'Hyg. tropic., 1904.

Cleland, J. B.—

1907. "The Diseases of Animals and Meat Inspection in Western Australia." Journ. Agric., West Australia, XV., 1907, p. 84-94 (p. 88).

1908. The same as above. Report Austr. Assoc. Adv. Sci., 1907 (1908), p. 685.

1909(*a*). The same—reprinted in Jour. Trop. Vet. Science, IV., 1909, p. 491-8.

1909(*b*). "Trypanosomiasis, etc., in Camels." Dept. Agric., West Austr., Bull. 34, 1909, p. 8, etc.

1909(*c*). Same as 1909(*b*)—reprinted in Jour Trop. Vet. Sci., IV., 1909, p. 316-344 (p. 324).

Cleland, J. B., and Johnston, T. H.—

1910(*a*). "Worm-Nests in Cattle due to *Filaria gibsoni*—Preliminary Report." Agric. Gazette, N.S. Wales, XXI., Feb., 1910, p. 173-4.

1910(*b*). The same—reprinted in Jour. Trop. Vet. Sci., V., 1910, p. 520-1.

1910(*c*). "Worm-nests (*Filariasis*) in Cattle." Annual Report of Govt. Bureau of Microbiology for 1909 (Sydney, N.S. Wales), I., 1909 (August, 1910), p. 91-99.

1910(*d*). "Worm-nests in Australian Cattle due to *Filaria* (*Onchocerca*) *gibsoni*, with Notes on Similar Structures in Camels." Jour. Proc. Roy. Soc., N.S.W., XLIV., 1910, p. 156-171.

1910(*e*). "On the Anatomy and Possible Mode of Transmission of *Filaria* (*Onchocerca*) *gibsoni*. Jour. Proc. Roy. Soc., N.S.W., XLIV., 1910, p. 171-189.

1910(*f*). The same as 1910(*c*).—Reprinted by the editor under the title "Worm-nests in Cattle due to *Filaria gibsoni*," in Jour. Comp. Pathol. Therap., XXIII., Dec., 1910, p. 335-353.

1911(*a*). The same as 1910(*a*),—reprinted in Jour. Meat and Milk Hygiene, I., Jan., 1911, p. 21-3.

1911(*b*). Reprint of 1910(*d*) and 1910(*e*) by Commonwealth Govt.—See under Gilruth and Sweet.

Curtice, C.—

*1892—"Parasites, etc." Jour. Comp. Med., and Vet. Archives, XIII. 7, p. 223-236.

Daniels, C. W.—

*1904. "Studies from Institute for Medical Research, Malay States," III., p. 17.

Diesing, K. M.—

1851—"Systema helminthum," II., 1851, p. 287.

De Does, J.—

*1904. "Wormfibromen en Filaria—embryoen in het bloed." Geneeskundig Tijd. v. Ned. Ind., Deel. XLIV. (5), Batavia, 1904, 15 pp.†

Dodd, S.—

1910(*a*). "Spiroptera reticulata in Cattle." Queensland Agric. Journal, Feb., 1910, p. 86.

1910(*b*). The same—reprinted in Jour. Trop. Vet. Sci., V., 1910, p. 518.

Dood,—

*Quoted by Neumann, 1910.

Ford, T. A.—

*1903. Veterinary Record, June, 14, 1903. See Tuck.

Fülleborn, F.—

1908. "Uber *Filaria volvulus*, Leuckt." Beiheft 7, zum. Arch. f. Schiffs, u. Tropenhyg., XII., 1908, pp. 1-17.

† I am indebted to the kindness of Mr. Henry Tryon, Government Entomologist, for the opportunity of seeing this paper.

Fülleborn, F., and Rodenwaldt, E.—
1908. "Filarien" in Real Encyclopadie d. ges. Heilkunde Aufl., 4, Vol., V., p. 81, etc.

Gibson, J.—
1893. "Notes on Certain 'Worm-nests' or 'Worm-Knots,' occurring in the cellular tissues of the brisket in Cattle." Trans. Intercol. Med. Congr. Austr. III., 1892 (1893), p. 576-580.

Gilruth, J. A., and Sweet, G.—
1911. "*Onchocerca gibsoni*, the cause of Worm Nodules in Australian Cattle," published by the Federal Govt. (Commonwealth of Australia—N.S.W. Govt. Printer, Sydney), 1911, p. 1-34.
On pages 35 to 58 is reprinted (almost in full), Cleland and Johnston, 1910 (*d*), and 1910 (*e*).

Hancock, G.—
1911. "Report on the Examination of Queensland Beef in the Port of London for the presence of *Spiroptera reticulata*" (August, 1910)—quoted by Editor Jour. Meat and Milk Hygiene, I., 1911, p. 24-6.

Johnston, T. H.—
1909. Proc. Linn. Soc., N.S. Wales, XXXIV., 1909, p. 412.
1911 (*a*). This paper, Proc. Roy. Soc., Q'land, 1911.
1911 (*b*). "A brief account of the worm nodules occurring in Cattle." Queensland Agric. Journal, Dec., 1911.

Johnston, T. H., and Cleland, J. B., see Cleland and Johnston
Labadie-Lagrave and Deguy, 1899. "Un cas de *Filaria vovulus*." Arch. d. Parasitologie, II., 1899, p. 451-460.

Leese, A. S.—
1910. Annual Report of the Veterinary Officer investigating Camel Diseases, for the year ending 31st March, 1910. p. 13.

Leiper, R. T.—
1911 (*a*). "Report on Onchocerciasis in Cattle, with Special reference to the structure and bionomic characters of the parasite." In Reports to the Local Govt. Board, etc., London. New Series, No. 45 (food reports, No. 11), 1911, p. 6-16.

1911(*b*). The same—reprinted in Jour. Trop. Med. Hyg., 15th March, 1911, p. 87-93.

1911(*c*). Dr. Leiper's conclusions republished in Q'land. Agric. Jour., April, 1911, p. 220-1. Under the title "Parasitic Nodules in Australian Beef."

1911 (*d*) Proc. Zool. Soc., Lond., 1911, p. 45.

Leuckart, R.—

*In Davidson's Hygiene and Diseases of Warm Climates, 1893.

Lingard, A.—

*1905. (*a*) "Observations on the filarial embryos found in the general circulation of the Equidæ and Bovidæ, and their probable pathological significance." London.

1905 (*b*). This paper referred to in Lancet, 23rd September, 1905, p. 893-4; Brit. Med. Jour., 11th Novr., 1905, p. 1299; Bull. d. l'Inst., Pasteur, III., 30th Nov., 1905, p. 933-4; Vet. Journ., XII. (n.s.), Dec., 1905, p. 381; Jour. Trop. Med. Hyg., VIII., 1st Sept., 1905, p. 268-9.

Looss, A.—

1905.—In Mense's Handb., d. Tropenkrankheiten, Leipzig, 1905.

Macfadden, A. W. J.—

1911. "Report on Meat Inspection at English Ports in regard to Onchocerciasis." In Reports to Local Govt. Board, etc.
New Series, No. 45. (Food Reports, No. 11), 1911, p. 1-5.

Manson, P.—

*1893. Skin Diseases, 1893, p. 893.

Morris, W.—

1881. Jour. Proc. Roy. Soc., N.S. Wales, XIV., 1880 (1881), p. 337.

Neumann, L. G.—

1905. A Treatise on the Parasites and Parasitic Diseases of the Domesticated Animals. Engl. transl., of French Edition.

1910. "Un nouveau Nematode parasite de Boeuf (*Onchocerca gutturosa*, n. sp.)"
Revue vétérinaire, May, 1911, p. 270-8. A

translation of the same, reprinted in Jour. Trop. Vet. Science. VI., 1911, p. 101-5.

Nicoll, W.—

1911. "Onchocerciasis in Cattle," Jour. Meat and Milk Hygiene I., 1911, p. 71.

Ouwehand—

* Mentioned by Neumann, 1910.

Pader, J.—

1901. "Filariose du ligament suspenseur du boulet chez le cheval." Arch, d. Parasitologie, IV., 1901, p. 58-95.

Park, A.—

1893. "Parasitic Diseases in the Colony of Queensland." Vet. Journ. and Annals of Comp. Pathol, XXXVII., 1893, p. 102-7.

1910. Report to Chief Inspector of Stock, also various newspaper articles (1893), summarised in Tyron 1910 (*a*), p. 82-3, p. 83-4.

Park, A. and Barnard, C. E.—

1894. See Barnard and Park.

Parsons, A. C.—

1909. "*Filaria volvulus*, etc." in Parasitology I., 1908, (1909), p. 359-368.

Penel, R.—

*1905 (*a*), "Les Filaires du sang de l'homme." Paris, 1905.

1905. (*b*), "Les Filaires" in Arch. d. Parasitol, IX., p. 187-204.

Pound, C. J.—

1909. In Rep. Agric. Dept. Q'land, for 1908-9 (1909), p. 97.

Prout, W.—

1901. (*a*) "A Filaria found in Sierra Leone (? Filaria *volvulus*, Leuckt)." Brit. Med. Jour., Jan. 1901, p. 209-211.

1901. (*b*) "Observations on *Filaria volvulus*." Arch. d. Parasitol., IV., 1901, p. 301-307.

Railliet, A.—

1895. *Traité d. Zool. médic. et agricole,* 1895.

Railliet, A. and Henry, A.—

1910. Les Onchocerques, etc. C. R. Soc. Biol., Paris, LXVIII., 1910, p. 248-251.

Robinson, T. B.—

1910. Report of the Agent-General (London) for Queensland, for 1909 (1910), p. 6.

1911. Report of the Agent-General (London), for Q'land for 1909 (1910).

Rodenwaldt, E.—

1908. "*Filaria volvulus*. Arch. f. Schiffs, u. Tropenhygiene, XII., 1908, p. 701-2.

Stanley, E.—

1893. Report to Board of Health, N.S. Wales, 1893.

Stiles, C. W.—

*1892. (*a*) "A word in regard to *Filariidae*, found in the body cavity of horses and cattle." Jour. Comp. Med. and Vet., Arch. XIII., 1892, p. 143-147.

*1892. (*b*) "A check list of Animal parasites of cattle, etc." Jour. Comp. Med. and Vet. Arch., 1892, p. 346-350.

1892. (*c*) "On the presence of *Spiroptera reticulata* in cattle." Stiles and Hassall, in their *Index Catalogue of Med. and Vet. Literature*, p. 2266, refer to the fact that the M.S. was lost in the mail. This paper is, therefore, unpublished.

*1894. "A preliminary catalogue of the parasites in the U.S. National Museum." Vet. Magazine, May, 1894.

Tryon, H.—

1910. (*a*) "Verminous tumours in cattle—Au[illegible] to [illegible] literature." Q'land Agric. Journal, 1910, p. [illegible]-4.

1910. (*b*) The same, reprinted in Jour. Trop. Vet. Sci., V., 1910, p. 511-516.

1911. "Verminous tumours of Cattle" in Report of Govt. Entomologist—Report Dept. Agric. Stock, Q'land, 1910-1911 (1911), p. 73.

Tuck, G. L.—

1907. "Observations on some worms found in the aortas of buffaloes and bullocks." Jour. Trop. Vet. Sci., II., 1907, p. 69-100.

1908. The same—published in Studies Inst. Med. Research, Malay Straits, Singapore, III., 1908, p. 19-66.

1907. Abstracts of same in Veterinary Record, XIX., 1907, p. 648-9.

Védy, L.—

*1906. "Filariose dans le district de l' Uele." Bull. Acad. roy. d. Méd. d. Belgique, Dec., 1906, p. 966-976.

Ziemann.—

*1907. Medizinal—berichte über die deutschen Schutzgebiete für das Jahr, 1905-1906. Berlin, 1907, p. 148, 179 (quoted by Fülleborn and Rodenwaldt, p. 84).

Editorial Abstracts and reviews—

1910. Brit. Med. Journ., 3 Dec., 1910, p. 1796-7—referring to Leiper, 1911 (*d.*)

1911 (*a*). Lancet, 4 Feb., 1911, p. 317—referring to Leiper, 1911 (*a*).

1911 (*b*). "Imported parasitic Colonial Beef." Jour. Meat and Milk Hygiene, I., 1911, p. 14-6. Abstracted from Annual Report of Med. Officer of Health for Corp. of London for 1909, p. 106- 7 and also from Hancock (*Q. V.*)

1911 (*c*). "Australian Meat Regulations." Jour. Meat and Milk Hygiene, I., 1911, p. 351.

The greater number of the abovementioned papers deal either wholly or in part with Onchocerciasis in cattle but some of them refer only to a similar condition in man, and a few to that met with in horses and camels. For further literature regarding Onchocerciasis in horses, see Pader (*l.c.*), as well as various vëterniary textbooks.

A CENSUS OF AUSTRALIAN REPTILIAN ENTOZOA.

By T. HARVEY JOHNSTON, M.A., D.Sc.,
Biology Department, University, Brisbane.

Read before the Royal Society of Queensland, October 28th, 1911.

THE present paper is the result of an attempt to collect references to the occurrence of entozoa and haematozoa in Australian reptiles, the term Australian being used in a wide sense so as to include forms from New Guinea and New Britain, as was done in a similar paper on avian entozoa. (Johnston, 1910 *c.*)

Many of the following records, more especially those which give merely the generic name of a nematode infesting a certain host, are of little value, but for the sake of completeness, they have been tabulated. Dr. Sweet (1908) has already collected a number of earlier records and published them in her Census of Australian Entozoa. The greater part of the literature referring to our reptilian haematozoa has been brought together in papers by Dr. Cleland and myself. (Johnston and Cleland, 1910 *a*; 1911 *a.*)

I have mentioned synonyms of the accepted specific name of the host only in those cases where a recorder of the occurrence of a parasite has referred to the host under such name.

OPHIDIA.

1. PYTHON SPILOTES Lacep, (syn. *Morelia spilotes.*) The Diamond Snake.

   **a* *Hæmogregarina shattocki*, Sambon & Seligmann, 1907, p. 284; Sambon, 1907, p. 310; Sambon, 1909, p. 111; Dobell, 1908, p. 291 (*Hæmogregarina* sp.); Laveran, 1908, p. 103.

**a*, denotes that the parasite is a Protozoon; *b*, that it is a Cestode; *c*, a Trematode; *d*, a Nematode; *e*, an Acanthocephalan; *f*, a Linguatulid.

Sambon's and Dobell's specimens were obtained in England, hence the original locality of the host is not recorded. As has been already pointed out (Johnston, 1909 *b*, p. 403), the snake must have come from the coastal district of New South Wales, if the popular and scientific names be correct.

b i., *Bothridium pythonis*, Blainville—more commonly known under the name of *Solenophorus megalocephalus* (*megacephalus*), Creplin.

Baird (1865 *a* p. 68 ; 1865 *b* p. 52) described a cestode under the name of *Bothridium arcuatum*, from this host. Monticelli and Crety (1891, reprint p. 17) after having examined Baird's original material stated it to be a synonym of Blainville's species. Krefft (1871, p. 214) referred to Baird's description. Specimens have been taken (Johnston 1910 *d*, p. 28) from diamond snakes killed near Sydney.

ii., *Sparganum* sp.

I have several Bothriocephalid larvæ from the subcutaneous tissues of this host (Hawkesbury River). They resemble at least externally, those recorded here from the connective tissues of other reptiles such as *Python variegatus* (N.S.W. and Queensland), *Varanus varius* (Burnett River), *Varanus gouldii* (Burnett River), *Dendrophis punctulatus* (Burnett River), while an allied form is occasionally found in certain frogs between the muscles of the thigh —*Hyla cærulea* (Burnett River and Sydney), *Hyla aurea* (Sydney and Perth, West Australia). The parasites referred to as *Bothriocephalus mansoni*, by Spencer (1892, p. 433) and by Hill (1905, p. 378) whose specimens were found in human beings, should perhaps be grouped merely as *Sparganum* sp., as their identity with Cobbold's forms is doubtful. Similar specimens of a *Sparganum* have been forwarded to me by Mr. Desmond, Government Veterinarian, Adelaide, who found them in the subcutaneous tissues of of a fox in South Australia. Probably the adult forms of these occur in snakes.

d. *Ascaris* sp., Krefft (1871, p. 214).

A large Ascarid occurs fairly frequently in this species and in *P. variegatus* (N.S.W. and Queensland),

2. PYTHON SPILOTES var. *variegata*, Gray (syn. *Morelia variegata*). The Carpet snake.

Unlike *P. spilotes*, this reptile has a very wide range over Australia.

a i., *Hæmogregarina shattocki*. Sambon & Seligmann. Johnston, 1909 *b*, p. 403; 1910 *b*, p. 42 (Enoggera, Brisbane); Johnston & Cleland, 1911 *a*, p. 487 (Burnett River).

ii., *Hæmogregarina moreliæ*, Johnston, 1909 *b*, p. 404; 1910 *b*, p. 43 (Abrolhos, West Australia).

iii., *Hæmogregarina megalocystis*, Gilruth, Sweet and Dodd, 1910, p. 234 (Victoria).

H. megalocystis is very like *H. bancrofti* from *Pseudechis australis* and *P. mortonensis* (*vide infra*), in regard to its detrimental effect on the parasitised erythrocyte. The other two haemogregarines will be referred to again (*vide infra*).

b i, *Bothridium pythonis*, Blainville—Johnston, 1910 *d*, p. 28 (N. S. Wales).

ii. *Sparganum* sp. in subcutaneous tissues (Hawkesbury River).

d *Ascaris* sp., Krefft, 1871, p. 214. Occurs also in *Python spilotes*.

3. PYTHON AMETHYSTINUS, Schn.

a *Hæmogregarina amethystina*, Johnston, 1909 *a*, p. 257; 1910 *b*, p. 42. (Port Curtis, Queensland.)

As a result of having examined haemogregarines from a considerable number of reptiles, it has become evident to me that these haematozoa vary a good deal in form and size. I now regard *H. amethystina*, *H. moreliae*, *H. shattocki* (from Australian pythons) and *H. pococki*, Sambon (from *Python molurus*) as being identical, and that they are all (as Dobell suggests in the case of Sambon's forms) synonymous with *H. pythonis* (Billet) Labbé. We cannot agree entirely with Dobell's suggestion that the generic name of the host might be added as a temporary specific name. We have adopted this method where convenient, but we have met with cases where this would be inapplicable. For example from species of *Pseudechis*, we have described two haemogregarines differing widely in regard to their

effect on the red cell; *Python variegatus* harbours at least two quite distinct forms; and then again we (J. & C., 1911 *a*) have met with a species in *Varanus Gouldi* which, to our minds, is certainly different from that usually met with in *V. varius*.

4. DENDROPHIS PUNCTULATUS, Gray. The green tree-snake.

a *Hæmogregarina dendrophidis*, Johnston & Cleland, 1910, *a*, p. 680 (Burnett River).

b *Sparganum* sp., from the mesentery and subcutaneous tissues—collected by Dr. T. L. Bancroft, Burnett River.

5. DIPSADOMORPHUS IRREGULARIS, Merrem.

All the following entozoa were collected by Dr. A. Willey in New Britain.

b *Phyllobothrium dipsadomorphi*, Shipley, 1900, p. 550.

d i., *Physaloptera obtusissima*, Molin; Stossich in Shipley, 1900, p. 559.

ii., *Physaloptera retusa*, Rud.; Stossich in Shipley, 1900, p. 559.

iii., *Diaphanocephalus appendiculatus* Molin · Stossich in Shipley, 1900, p. 560.

f. *Porocephalus tortus*, Shipley, 1898, p. 52; 1900, p. 563.

6. DIEMENIA PSAMMOPHIS, Schl. The whip snake.

No parasites have been described from this host though a mere mention of the occurence of *Porocephalus* sp., *Physaloptera* sp., and *Ascaris* sp. has been made (Johnston, 1910, *a*, p. xviii; 1910 *d*, p. 309), Sydney.

7. DIEMENIA RETICULATA, Gray (perhaps more correctly D. PSAMMOPHIS var. RETICULATA).

This Western Australian reptile is sometimes known locally as a "spinifex snake." Krefft recorded the presence of some parasites but did not give any indication of the locality, in fact one is led to believe that the host came from Queensland or New South Wales. As a matter of fact, his material was from Western Australia. Dr. J. B. Cleland has been kind enough to hand over to me specimens

which he collected in North Western Australia, and I have had an opportunity of inspecting Krefft's collection also. The latter is very indifferently preserved.

a *Hæmogregarina* sp., Johnston & Cleland, 1910 *a*, p. 682. (N.W. West Australia.)

d *Physaloptera* sp., Krefft, 1871, p. 214.

I have a few specimens collected by Dr. Cleland.

e *Echinorhynchus* sp., Krefft, 1871, p. 214.

I have some immature echinorhynchus from the subperitoneal tissues (Johnston, 1910 *d*, p. 659) collected by Dr. Cleland.

f *Porocephalus* sp., Krefft (1871, p. 214) recorded the presence of *Pentastomum* in the lung of the above snake. His specimens are specifically identical with those which I have received (Johnston, 1910 *d*, p. 28) from Dr. Cleland. For the present they may be provisionally identified as *Porocephalus teretiusculus* (Baird), which they very closely resemble.

8. DIEMENIA TEXTILIS, Dum. & Bibr. The brown snake.

a *Trypanosoma* sp., Tyrie and Love, 1906, p. 408.

This record is based upon the following extract. " Dr. Love exhibited under the microscope a Trypanosome from the blood of a brown snake, sent by Dr. Tyrie." North Queensland.

d *Physaloptera* sp., Johnston, 1910 *d*, p. 309. (Sydney).

e *Echinorhynchus* sp., Johnston, 1910 *a*, p. xi; 1910 *d*, p. 659.

Adult forms in the intestine, and larval forms in the subperitoneal tissues. (Sydney; Hunter River.)

Bennett in his book " Wanderings in New South Wales, 1834," Vol. I., p. 215, refers to the presence of bright red worms one and a-half to two inches long, affecting the lung and perforating the stomach wall of the brown snake. The lung worm is possibly *Porocephalus teretiusculus.* The stomach worm may have been a *Diaphanocephalus* or other Strongyle.

9. PSEUDECHIS PORPHYRIACUS, Shaw. The Black snake.

a *Hæmogregarina pseudechis*, Johnston, 1909 *b*, p. 406; 1910 *b*, p. 43 (Sydney); Johnston & Cleland, 1911 *a*, p. 487 (Hawkesbury River).

b i., *Proteocephalus gallardi*, Johnston, 1911 *a*, p 175 (from various districts of New South Wales and from Gippsland, Victoria). Previously recorded as *Ichthyotaenia* sp. (Johnston, 1910 *a*, p. xi.; p. xviii.)

This tapeworm also infests the Tiger Snake, *Notechis scutatus* (Sydney district).

ii., *Sparganum* sp. Larval forms of a Bothriocephalid have been taken by me from the subperitoneal tissues (Sydney).

c Hemiurus sp., from the intestine. Also previously recorded from *Denisonia superba* (Johnston, 1910 *a*, p. xviii) under the synonym *Apoblema* (Sydney district).

d Diaphanocephalus sp. (*Kalicephalus* sp.) from the alimentary tract (Sydney).

e Echinorhynchus sp., Johnston, 1909 *c*, p. 590. From the rectum. A common parasite (Hawkesbury River; Sydney).

f Porocephalus teretiusculus (Baird).

This parasite infests the lungs of some of our venomous snakes and has generally been referred to as *Pentastomum teretiusculum*. Baldwin Spencer (1888, p. 110) first recorded it from the host from King Island as *Pentastomum* sp., but later (1892, p. 1) gave a full account of it under Baird's name. (Victoria.) Shipley (1898, p. 77) summarised Spencer's and Baird's accounts. I here record the occurrence of the parasite in New South Wales (Blue Mountains).

10. PSEUDECHIS AUSTRALIS, Gray. A Northern Black Snake.

a Hæmogregarina bancrofti, Johnston & Cleland, 1911 *a*, p. 486. Films kindly forwarded by Dr. T. L. Bancroft, from Eidsvold, Burnett River, Queensland.

b i. *Proteocephalus* sp. (Eidsvold, Burnett River.

This cestode is closely related to but not identical with, *P. gallardi*, but a tapeworm which I have taken from *Denisonia superba* belongs to the same species as the parasite from this host.

ii. *Sparganum* sp.

From the mesentery collected from a snake, forwarded by Dr. Bancroft. (Eidsvold, Burnett River).

11. PSEUDECHIS MORTONENSIS, De Vis.

a Hæmogregarina bancrofti, Johnston & Cleland, 1911 *a*, p. 486. (Eidsvold, Burnett River.)

12. DENISONIA SUPERBA, Gunther. (Syn. *Hoplocephalus superbus*). The Copper-headed Snake.

b i *Piestocystis hoplocephali*, Hill, 1894, p. 49.

Occuring in cysts in the peritoneum around the intestine. (N.S.W.)

ii, *Proteocephalus* sp., Johnston, 1910 *a*, p. xviii.

This cestode is specifically identical with that referred to above as occurring in *Pseudechis australis*, and differs only in minor details from *Proteocephalus gallardi*. Recorded from Sydney district under the synonym *Ichthyotaenia* sp.

c i. *Hemiurus* sp.

From the oesophagus (Sydney). Recorded as *Apoblema* sp. (Johnston, 1910 *a*, p. xviii). It also infests the Black Snake.

d Trichosomum sp., (Johnston, 1910 a, p. xviii). From the intestine. (Sydney.)

f Porocephalus teretiusculus, (Baird).

This pentastome was described by Baird (1862, p. 114) having been taken from the lung of a snake belonging to this species which had died at the London Zoological Gardens. Krefft (1871, p. 211) hereby mentioned Baird's species. B. Spencer (1892, p. 1) found the parasite in *D. superba* (Victoria) as well as in *Pseudechis porphyriacus*. Shipley (1898' p. 76) referred to its occurrence in this host. *Porocephalus* sp., recorded by me (1910 *a*, p. xviii) from the same host (Sydney district) belongs to Baird's species.

13. NOTECHIS SCUTATUS, Peters—syn. *Hoplocephalus curtus*. D. &. B. The Tiger Snake.

b Proteocephalus gallardi, Johnston.

Tapeworms which I have taken from a Tiger Snake killed near Sydney, have been identified as belonging to the same species as those from the black snake. *Notechis scutatus* is thus a newly recorded host for this entozoon. Kitson's reference (1904, p. 147) to the occurrence of a long cestode in this host is of no value.

d Physaloptera sp., Johnston, 1909 *d*, p. 590—from the stomach and duodenum (Sydney district).

14. ACANTHOPHIS ANTARCTICUS, Shaw. The death adder.

d Physaloptera antarctica, Linstow, 1899, p. 15. (South Australia).

15. FURINA OCCIPITALIS, D. & B. The ringed snake.

d Diaphanocephalus, sp. (Eidsvold, Burnett River).

16. A LARGE UNIDENTIFIED SNAKE—from the Bismarck Archipelago.

d i *Physaloptera*, sp. Linstow, 1897, p. 286.

ii *Ascaris papillifera*. Linstow, 1897, p. 281.

LACERTILIA.

17. GYMNODACTYLUS MILIUSII, Bory. (Syn. *Phyllurus miliusii*.)

d Ascaris sp. Krefft, 1871, p. 214.

18. DIPLODACTYLUS VITTATUS, Gray, syn. *D. ornatus*, Gray.

f Porocephalus sp. Recorded by Krefft (1871, p. 214) as *Pentastomum* sp.

19. ŒDURA TRYONI, De Vis

a i *Hæmogregarina* sp.

ii *Hæmocystidium* sp.

Both were found by Dr. Cleland and myself in a film kindly forwarded by Dr. T. L. Bancroft (Eidsvold, Burnett River).

20. LIALIS BURTONII, Gray. The slow worm.

b Piestocystis lialis, Hill, 1894, p. 61. (N.S.W.)

d Physaloptera sp. Johnston, 1910 *a*, p. xviii. (Sydney.)

21. AMPHIBOLURUS MURICATUS, White.

d Strongylus paronai, Stossich, 1902.

22. AMPHIBOLURUS BARBATUS, Cuv. The Jew lizard.

d Strongylus paronai, Stossich.

I am referring to Stossich's species some Strongyles collected by Dr. Cleland in the Moree district, N.S. Wales.

23. PHYSIGNATHUS LESUEURII, Gray. The water dragon.

d Microfilaria sp. Johnston & Cleland, 1911 a, p. 489.

Found in blood smears forwarded by Dr. Bancroft (Eidsvold) Burnett River), who afterwards discovered the

adults in the mesenteric veins. The finding of filarial embryos in the blood of reptiles is rare, this being the only recorded instance as far as Australian reptilia are concerned.

24. CHLAMYDOSAURUS KINGII, Gray. The frilled lizard.

d Strongylus paronai, Stossich.

Some specimens taken by me from a frilled lizard forwarded by Dr. Bancroft (Burnett River), are provisionally referred to this species.

25. VARANUS INDICUS, Daud.

b Palaia varani, Shipley, 1900, p. 548.

d Physaloptera varani, Parona. Stossich in Shipley, 1900, p. 560.

Both species were collected by Dr. Willey in New Britain. In regard to *Palaia varani*, the account given does not allow of the genus being properly placed. It seems to me probable that *Palaia* is a synonym of *Proteocephalus.*

26. VARANUS VARIUS, Shaw. The monitor.

a Hæmogregarina varanicola, Johnston & Cleland, 1910 *a*, p. 683 (N.S.W.) ; 1911 *a*, p. 487. (Burnett River)

Hæmogregarina sp. Gilruth, 1910, p. 36 (Victoria) is the same.

b i *Proteocephalus tidswelli*, Johnston, 1910 *a*, p. 103 ; 1910 *b*, p. 87 (N.S.W.)

This species was first described as *Ichthyotaenia* (*Acanthotænia*) *tidswelli*, but Benedict (1), La Rue (2) and others have shown that Weinland's genus has priority over Lonnberg's *Ichthyotaenia.* I have already shown (1910 *a*, p. 113-114) that Linstow's genus *Acanthotaenia* is a synonym of *Proteocephalus.*

ii *Sparganum* sp.

From the sub-peritoneal tissue. (Burnett River—collected by Dr. Bancroft.)

d Physaloptera sp—*P. varani*, Parona ?

Johnston, 1909 *e*, p. 115 ; 1910 *a*, p. xi ; 1910 *b*, p. 88 (N.S.W.)

(1.) Benedict, H.—On the Structure of Two Fish Tapeworms, from the genus *Proteocephalus*. Weinland—Jour. Morphology XVI, p. 337; Studies from Zool. Lab. Univ., Nebraska, No. 33, Jan., 1900.

(2.) La Rue, G.—On the Morphology and Development of a New Cestode of the genus *Proteocephalus*. Weinland.—Studies Zool. Lab Univ., Nebraska, No. 95, Dec., 1909.

27. VARANUS GOULDII, Gray. Gould's Monitor.

a Hæmogregarina gouldii, Johnston & Cleland, 1911 *a*, p. 488. Found in films forwarded by Dr. Bancroft from Eidsvold.

b i *Proteocephalus tidswelli*, Johnston.

Some fragments collected from a specimen (Burnett River) probably belong to this species.

ii *Sparganum* sp.

Specimens were forwarded to me by Dr. Bancroft (Burnett River) who found them in the subperitoneal tissues.

d Physaloptera sp—*P. varani*, Parona ? Johnston, 1910 *d*, p. 524.

I have specimens from this host from Queensland (Dr. Bancroft—Eidsvold), West Australia (Dr. Cleland), Victoria (Mr. A. S. LeSouef) and New South Wales (T.H.J.)

28. VARANUS sp. From New Guinea.

b i *Proteocephalus biroi* (Ratz). Ratz, 1900 *a*, p. 658.
ii *Proteocephalus saccifera* (Ratz). Ratz, 1900 *a*, p. 658.
iii *Taenia mychocephala* (Ratz), 1900 *a*, p. 659.

The two former were described under the genus *Ichthyotaenia*. A description of the three species is given in Ratz, 1900 *a*, p. 657 ; 1900 *b*, p. 980 ; 1901, p. 329.

29. EGERNIA CUNNINGHAMI, Gray.

Krefft (1871, p. 214) mentioned finding worms in this host. They appear to belong to the Oxyuridae. (N.S.W.)

30. EGERNIA WHITII, Lacep. (Syn. *Lygosoma* (*Hinulia*) *whitii*, Steind.)

d Ascaris sp. Krefft, 1871, p. 214.

31. TRACHYSAURUS RUGOSUS, Gray.

d Oxyuris tuberculata, Linstow, 1904, p. 300 (Australia).

32. TILIQUA SCINCOIDES, White. The Common sleeping or Blue-tongued lizard.

a Hæmogregarina tiliquae, Johnston & Cleland, 1911, *a* p. 484. (Hawkesbury River.)

d Physaloptera sp. Johnston, 1910 *a*, p. xi (Sydney).

33. TILIQUA GIGAS, Schn., syn. *Cyclodus gigas*, Schn.

d Physaloptera sp. Krefft, 1871, p. 214.

Boulenger (Cat. Reptilia-Lizards, Edit. 2, III., p. 145) states that the localities from which this lizard is known are

New Guinea. Moluccas and Java, Australia not being mentioned.

34. TILIQUA OCCIPITALIS, Peters. (Syn. *Cyclodus occipit. lis.*)
   d *Physaloptera antarctica*, Linstow, 1889, p. 15 (South Australia).

35. LYGOSOMA (HINULIA) TAENIOLATUM, White.
   a i *Hæmogregarina* sp. Johnston & Cleland, 1911 a, p. 479.
   ii *Trypanosoma* sp. Johnston & Cleland, 1911 *a*, p. 479.

Both of these haemotozoa were found in a film forwarded by Dr. Bancroft (Burnett River).

e *Echinorhynchus* sp.

From the intestine. (Hawkesbury River, N.S.W.)

f *Porocephalus* sp.

Krefft (1871, p. 214) recorded the occurrence of *Pentastomum* in the lung.

36. LYGOSOMA (HINULIA) QUOYI, Dum. & Bibr.
   a *Hæmogregarina hinuliæ*, Johnston & Cleland, 1910 *a*, p. 684, Hawkesbury River); 1911 *a*, p. 487 (Sydney).
   e *Echinorhynchus* sp., Johnston, 1909, *d*, p. xxix. (Hawkesbury River). From the intestine.

37. LYGOSOMA (HINULIA) TENUE, Gray.
   d *Physaloptera* sp., Johnston, 1910 *a*, p. xi. (Hunter River.)

CROCODILIA.

No entozoa have, as far as I know, been described from Australian crocodiles.

CHELONIA.

38. CHELONIA MYDAS, Linn. (Syn. *Chelone mydas*). The Green Turtle.
   c i *Amphistoma scleroporum*, Creplin.
   ii *Octangium sagitta*, Looss.

Neither of these trematodes had been previously recorded from Australian hosts. They were known from Mediterranean turtles. *Amphistoma scleroporum* is insufficiently known, Braun's single specimen (Braun, 1901, p. 56) which he referred to Creplin's species, being immature. It was 8.2 mm. long by 2.2 mm. broad and possessed only rudiments of the genitalia. Looss (1901, p. 623) in his descrip-

tion of *A. spinulosum* from *Chelone mydas* from Egypt, states that mature specimens are from 5 to 5.6 mm. long and are thus much smaller than Braun's specimen of *A. scleroporum*. Later (1902, p. 430) he referred to specimens 7.5 to 8 mm. long, about 1.6 mm. broad and 1 to 1.6 mm. in thickness, and mentioned that they were of a pale flesh-red colour when alive. He also stated that the species was unmistakeably like Braun's form. My specimens (collected on Mast Head Island, at the southern end of the Barrier Reef by Mr. L. Harrison in October, 1910) are from 7.5 to 9 mm. long by from 2.4 to 3 mm. broad. The characters are those of *A. scleroporum*. The anatomy is strikingly like that figured by Looss (1902) for *A. spinulosum*, the main difference being that, in some of my specimens, the vitellaria extend a little further forward and the testes are more markedly lobed.

Octangium sagitta was originally described by Looss (1899, p. 772) as *Microscapha sagitta*, being transferred later to *Octangium* (1902, p. 685).

39. Erethmochelys imbricata L. Syn. *Chelone imbricata* L.

Shipley (1900, p. 532) described a trematode which he regarded as belonging to *Monostomum trigonocephalum* Rud., the material having been collected by Willey (New Britain ?) Braun (1901) recognised that Shipley had had more than one species before him. He stated (p. 51) that *M. trigonocephalum* Shipley 1900, p. 532, pl. 54, fig. 1, did not belong to Rudolphi's species but to *M. rubrum* (p. 45) ; that the form figured on plate 44, figs. 1*c*, 3, 4, 5, 7, as well as *Cricocephalus delitescens* Looss (1899, p. 759) belong to *M. album* ; and (p. 38) that *Pronocephalus trigonocephalus* Looss (1899, p. 756) as well as some of Shipley's forms belong to Rudolphi's species. In 1901 Looss (1901, p. 566) recognised that his *trigonocephalus* was distinct from Rudolphi's and consequently re-described it as a new species *Pr. obliquus*, while Rudolphi's species was made (1901, p. 567 ; 1902, p. 548) the type of a new genus *Pleurogonius*. He stated (1902, p. 549) that some of Shipley's forms, viz., those described and figured, belonged to this species, while certain forms which were figured but not described, belonged to *Cricocephalus albus* (K. & Hass.) Looss, which Looss admitted

(p. 532) to be identical with his *C. delitescens*; and that (p. 527) Braun's account (1901) of *M. trigonocephalum* included at least two distinct species, *Pronocephalus obliquus* Looss (on page 40) and *M. trigonocephalum* Rud. (on p. 3) and in all probability (according to Looss, 1902, p. 557 footnote) includes also a third form, *Epibathra crassa* Looss. He regarded *M. trigonocephalum* of Van Beneden 1859 and of Walter, 1893, as belonging to *Pleurogonius longiusculus* Looss (1901, p. 568; 1902, p. 558).

From the foregoing it appears that Willey's collection really contained the following:—

i *Pleurogonius trigonocephalum* (Rud.) Looss.

ii *Cricocephalus albus* (K. & Hass.) Looss.

Braun believed that *Monostomum rubrum* K. & H. was also present. Looss (1902) does not refer to this species.

40. A Sea Tortoise.

The following trematodes were identified by Braun (1899) from material collected in the Bismarck Archipalego by Dahl. He dealt with a number of other forms from Chelonians in the same paper.

i *Distomum gelatinosum* Rud. (p. 716).
ii *D. irroratum*, Rud. (p. 717).
iii *Monostomum album*, K. & Hass. (p. 723).
iv *M. rubrum*, K. & Hass. (p. 724).

D. gelatinosum is called *Rhytidodes gelatinosus* by Looss (1901, p. 563; 1902, p. 445); *D. irroratum* becoming *Pachypsolus irroratus* (Rud.), Looss (1901, p. 55; 1902, p. 485); and *M. album*, *Cricocephalus albus* (Looss, 1902, p. 532).

Braun (1899) has been misquoted by Dr. Sweet (1908 pp. 459, 460, 463, 464) who includes the following species in error as having been amongst those collected in New Britain by Dahl.

i *Amphistoma scleroporum*, Crepl. (p. 725).

ii *Distomum amphiorchis*, Braun (p. 719). *i.e.*, *Orchidasma amphiorchis* (Braun) Looss, 1901, p. 560; 1902, p. 463.

iii *Distomum anthos*, Braun (p. 720)—*Calycodes anthos* (Braun) Looss, 1901, p. 565; 1902, p. 458.

iv *Distomum cymbiforme*, Rud. (Braun, p. 720).—*Phyllodistomum cymbiforme* (Rud.) Braun, 1901,

p. 10—*Plesichorus cymbiforme* (Rud.) Looss, 1901, p. 555; 1902, p. 469.

v *Monostomum reticulare* v. Ben., Braun, 1899, p. 725—*Microscaphidium reticulare* (v. Ben.) Looss, 1902, p. 691.

vi *Monostomum trigonocephalum* (Rud.) Looss, 1901 p. 567; 1902, p. 548.

41. Chelodina longicollis, Shaw. The long-necked Tortoise.

a i *Hæmogregarina clelandi*, Johnston. Johnston & Cleland, 1911 *a*, p. 482. (Burnett River—Dr. Bancroft; Murray River, South Australia). Originally described from *C. oblonga*.

ii *Hæmocystidium chelodinæ*, Johnston & Cleland, 1909 *a*, p. 97; 1910 *b*, p. 38 (Sydney).

iii *Trypanosoma chelodina*, Johnson (A. E.), 1907, p. 26 (Murray River, SouthAustralia); Johnston & Cleland, 1911 *a*. p. 479 (Murray River, South Australia; Burnett River—Dr. Bancroft).

42. Chelodina oblonga, Gray.

a i *Hæmogregarina clelandi*, Johnston, 1909, p. 407, 1910 *b*, p. 44; Johnston & Cleland, 1910 *a*, p. 67 footnote; 1911 *a*, p. 482 (Perth, West Australia).

ii *Hæmocystidium chelodinæ*, Johnston & Cleland, 1911 *a*, p. 482 (Perth, West Australia)—originally described from *C. longicollis*.

43. Emydura krefftii, Gray.

a i *Hæmogregarina clelandi*, Johnston. Johnston & Cleland, 1911 *a*, p. 483 (Burnett River).

ii *Trypanosoma chelodina*, Johnson (A. E.). Johnston & Cleland, 1911 *a*, p. 480 (Burnett River.)

In our paper (1911 *a*) we have given other localities in Queensland from which parasitised blood films were taken by Dr. Bancroft, viz., Enoggera and Petrie's Creek. The species of tortoise from these localities has been identified as *Emydura macquariæ*, hence the information contained in that paper will need to be modified in accordance with the details as to host and localities contained in this communication. *Hæmocystidium chelodinæ* recorded by us

(1911 *a*, p. 481) from this host from Petrie's Creek, near Brisbane, thus should be listed under *E. macquariæ* (*vide infra*).

44. EMYDURA MACQUARIÆ, Gray.

a i *Hæmogregarina clelandi*, Johnston.

ii *Hæmocystidium chelodinæ*, Johnston & Cleland.

iii *Trypanosoma chelodina*, Johnson (A. E.).

These three haematozoa were recorded (J. & C., 1911 *a*) as being taken from *E. Krefft i* from Petrie's Creek. The host is really *E. macquariæ*, a very closely related species. All of the above were found in a blood smear taken in this locality by Dr. Bancroft (J. & C., 1910 *a*, p. 679).

45. ELSEYA DENTATA, Gray.

c Amphistoma sp. Krefft, 1871, p. 213.

d Ascaris sp. Krefft, 1871, p. 213.

From Northern Queensland Rivers.

My thanks are due to Dr. Bancroft, who has greatly assisted me by forwarding material from various parts of Queensland; Mr. D. Fry of the Australian Museum, Sydney, who has identified most of the hosts for me; Dr. J. B. Cleland; Messrs. S. J. Johnston (Sydney University), D. Fry, F. H. Taylor, L. Gallard and L. Harrison for sending specimens to me.

LITERATURE.

1862 Baird, Proc. Soc. London 1862, p. 114.

1865*a* Baird, *Ibid.*, 1865, p. 68.

1865*b* Baird, Ann. Mag. Nat. Hist. (3) XVI., p. 52.

1899 Braun, Centr. f. Bakt., Orig., I., XXV., p. 714.

1901 Braun, Mitt. Zool. Mus. Berlin, II., 1901.

—— Cleland & Johnston—see Johnston & Cleland.

—— Crety & Monticelli—see Monticelli & Crety.

1908 Dobell, Parasitology I., 1908 (1909), p. 291.

—— Dodd, Gilruth & Sweet—see Gilruth, Sweet & Dodd.

1910 Gilruth, Proc. Roy. Soc. Vict., XXIII., p. 36.

1910 Gilruth, Sweet & Dodd, *Ibid.*, XXIII., p. 231.

1894 Hill, Proc. Linn. Soc. N.S. Wales, IX., 1894.

1905. Hill, Trans. Inter. Med. Congr. Austr., 1905, p. 378.

1907 Johnson (A. E.), Austr. Med. Gaz., XXVI., p. 26.

1909*a* Johnston (T. Harvey), Rec. Austr. Museum, VII., p. 257.

1909*b* Johnston, Proc. Linn. Soc. N.S. Wales, XXXIV., p. 400.

1909*c* Johnston, *Ibid.*, XXXIV., p. 590, etc.

1909*d* Johnston, Jour. Roy. Soc. N.S. Wales, XLIII., p. xxix.

1909*e* Johnston, *Ibid.*, XLIII., p. 103.

1910*a* Johnston, *Ibid.*, XLIV., p. xi; p. xviii.

1910*b* Johnston, Ann. Rep. Bureau Microbiology, Sydney, I., pp. 38, 41-45, p. 87 (abstracts of 1909*a*, 1909*b*, 1909*e*.)

1910*c* Johnston, Jour. Roy. Soc. N.S. Wales, XLIV., p. 84.

1910*d* Johnston, Proc. Linn. Soc. N.S. Wales, 1910, p. 28, p. 309.

1911*a* Johnston, Annals Queensland Museum X., 1911, p. 175

1911*b* Johnston, The present paper.

1909*a* Johnston & Cleland, Jour. Roy. Soc. N.S. Wales, XLIII., p. 97.

1910*a* Johnston & Cleland, Proc. Linn. Soc. N.S.Wales, XXXV., p. 400.

1911*a* Johnston & Cleland, Proc. Linn. Soc. N.S. Wales XXXVI., p. 479.

1904 Kitson, Vict. Naturalist, XXI., 1904-5, p. 147.

1871 Krefft, Trans. Ent. Soc. N.S. Wales, II., 1871.

1897 Linstow, Arch. f. Naturg., LXIII., 1897.

1899 Linstow, Mitt. Zool. Mus. Berlin, I., (2), p. 15.

1904 Linstow, Arch. f. Naturg., LXX., p. 300.

—— Love & Tyrie—see Tyrie & Love.

1908 Laveran, C. R., Acad. Sci., CXLVII., 1908, p. 103.

1899 Looss, Zool. Jahrb., XII., 1899, p. 521.

1901 Looss, Centr. f. Bakt., Orig., I., XXX., p. 555—; p. 618—.

1902 Looss, Zool. Jahrb., XVI., 1902, p. 411.

1891 Monticelli & Crety, Mem. R. Accad. Sci. Torino, Ser. II., XLI., 1891.

1900*a* Ratz. Centr. f. Bakt., Orig., I., XXVIII., p. 657.

1900*b* Ratz, C. R. Soc. Biol., LII., 1900, p 980.

1901 Ratz, Arch. d. Parasitol., IV., 1901, p. 329.

1907 Sambon, Trans. Pathol. Soc. London. LVIII., 1907.

1909 Sambon, Jour. Trop. Med. Hyg., XII., 1909.

1907 Sambon & Seligmann, Proc. Zool. Soc. Lond., 1907.

1898 Shipley, Arch. d. Parasitol, I., 1898.

1900 Shipley in Willey's Zool. Results V., 1900, p. 531

1892 Spencer, Trans. Inter. Med. Congr. Austr., 1892, p. 433.

1888 Spencer (Baldwin), Proc. Roy. Soc. Vict., I., 1888, p. 110.

1892 Spencer (Baldwin), Q. J. M. S., (N.S.), XXXIV 1892-3, p. 1.

1902 Stossich, Bull. Mus. Genova. 1902.

1908 Sweet, Proc. Roy. Soc. Vict., XXI., 1908 (1909), p. 454.

—— Sweet, Gilruth & Dodd,—see Gilruth, Sweet & Dodd.

1906 Tyrie & Love, Austr. Med. Gaz., XXV., p. 408.

ON A WEAK POINT IN THE LIFE-HISTORY OF NEOCERATODUS FORSTERI, KREFFT.

By THOMAS L. BANCROFT., M.B., Edin.

(*Read before the Royal Society of Queensland, 2nd December*, 1911.)

THE writers on Ceratodus, so far as I am aware, have not touched upon a very important matter in connection with the life-history of the fish.

From the earliest date (1870) no one seemed ever to have caught a small Ceratodus, *i.e.*, a fish, an ounce to a pound or so in weight; specimens, about six pounds or there about, were occasionally taken and regarded as very small ones. The Blacks even were unable to find the little fellows; it was a mystery where they hid themselves; some people thought that they went up small creeks, whilst others thought that they lived in the mud and some comparatively recent observations have lent support to the latter theory*.

It appears that during a dry spell at Cooranga, on the Burnett, when a lagoon was drying up and all the fish were concentrated in a small space, search was made for Ceratodus; several small fish were taken out of the mud; they were fish about fourteen inches in length, probably about four pounds in weight; these were the smallest hitherto seen, that is in their natural home. Mr. Thomas Illidge has, however, reared fish from the ova up to eight months; they were then two and a half inches in length.

All the fishes, in a lagoon drying up, are compelled to sink into the mud or debris, so it cannot be said of those small Ceratodus, that they were in the mud of their free will. There are stretches of the Burnett River with a sandy, and other parts with a rocky bottom, in which

* Notes on the Ceratodus by D. O'Connor, Rep. Aust. Assn., Ad. Science, Vol. XII., p. 383.

numerous full-grown Ceratodus live, and these fish spawn every September; where are the young fish in such lagoons? There is no mud, but I suppose those who have advocated the mud theory, regard the debris at the bottom, consisting of rotten leaves, sticks and water weeds, as mud.

I have endeavoured to find the little fish by scooping out water weeds, mud and debris of every kind both in the river and in the contributory creeks; I have found young forms of every fish inhabiting the Burnett with the exception of Ceratodus. I have tried liming a pool with the intention of suffocating all the fish; I have dynamited holes, but never was a Ceratodus under six pounds taken. I have had conversations with a good many men, who have, for a life-time, dynamited mullet, and they have all had the same experience in that no little "salmon" have been seen.

With a fishing net having a six inch mesh, that is three inches square, set across a deep lagoon, there is no difficulty whatever in meshing forms from six to thirty pounds in weight. With a net of three inch mesh, one might reasonably expect to take smaller forms, but although attempts were repeatedly made both by day and night, night being the best for large fish, no success followed.

Dredging in places, where last year ova were plentiful and even as recently as a month ago, no young fish can be procured although dead ova are to be found. With this experience, I have concluded that there are no young forms at the present time.

Ceratodus was a common fish all over the world ages ago, but is now restricted to the two rivers in Queensland, the Mary and the Burnett.

It is therefore nearing its extinction. There is a weak spot in its life-history; this occurs after the little fish leaves the egg, or rather its gelatinous envelope; it is then a helpless little creature only able to move a few inches at a time and unable to balance itself, lying upon its side at the bottom for hours on a stretch; it remains in this helpless state for several days, and during this critical period of its life it is preyed upon by the larvæ

of dragon-flies; so helpless is it and so numerous its enemies that I am of opinion not one individual ever escapes in an ordinary season. In aquaria, it is extremely difficult to prevent the little fish from being devoured by insects; so far I have been unable from this cause to rear fish longer than ten weeks; some of the insects live in the stems of the water weeds and elude the most careful detection; you may daily watch your little fish thrive right up to its disappearance when further search brings to light a larva or a part of the fish's remains.

It is probable that certain meteorological conditions occur, perhaps once or twice in a century, during which the enemies of the young Ceratodus are removed. Such a condition might occur in this manner; during a prolonged drought when the Burnett River is reduced to a chain of lagoons, the enemies would be absent; the enemies consisting of small fishes, prawns and insects, live in the water weeds in comparatively shallow water, water to a depth of six feet or so; now in a drought the water would have receded past this level and the small fish have been devoured by the larger ones, eels especially, so that eventually only large fish remain; a flood following would give the Ceratodus freedom from its enemies, possibly for a number of years.

During a flood in an ordinary season all the little fish and insects keep well to the edge and go up gullies, and when the water recedes return again to the same parts of the river which they left. Large trees having been undermined by the flood and falling into the river, are the means of causing a considerable wash out, deep pools or lagoons below the obstruction resulting; such new lagoons would be free from water weeds and it is possible that a flood occuring in the winter might bring about conditions favourable to the propagation of Ceratodus in those new lagoons.

As it is manifest that without assistance or unless natural favourable conditions occur in the near future, this interesting fish will shortly be extinct, endeavours should be made at once to prevent the extinction.

Mr. D. O'Connor, on behalf of this Society, which received a subsidy from the Queensland Government

for the purpose, was instrumental in transferring many living specimens from the Mary to the Enoggera, Condamine and Logan Rivers; it is very likely that both sexes were taken to each spot, for recent examination of fifty Ceratodus shewed that there were twice as many males as females; in any bunch of five specimens both sexes would occur. There is no doubt that the fish survived and thrived in their new abode, as specimens have been caught twenty years later.

Nevertheless, I am of opinion that that method will not suffice to prevent the extinction, and propose the following scheme. Let a suitable lagoon be constructed and stocked with a dozen fish: so arranged that the fish could be caught in September, the spawning season, transferred to a hatchery and there stripped of their ova, if that be possible with Ceratodus: the young fish reared until a year old and then liberated in weedy rivers. A pond, circular in shape, as large as possible, constructed preferably by excavation, bricks and cement, with abrupt walls; one half to be four feet in depth and planted with Vallisneria and Hydrilla, and one half twelve feet deep. Preparatory to catching the fish any that might be in the weedy portion could be made to go into the deep water by poking a long stick into the weeds: by means of a frame, the width and depth of the deep portion, covered with wire netting and lowered into the water at the junction of the shallow with the deep part and carried towards the end, the fish would be imprisoned: if the extreme end were made narrow and shallow the fish could be more easily captured. If it were found that Ceratodus was a fish that could not be stripped of its ova, it would be advisable to construct a small pond, the same absolutely protected in every way from insects, into which the fish could be transferred during the spawning season: the ova could be obtained and hatched in aquaria if that were considered advisable. Failing for want of funds to get the scheme as outlined carried out, I would recommend that a small hatchery be arranged and some one sent to Miva on the Mary River, in September, to procure ova.

Ceratodus spawns in weed beds in still water close to the edge of the river during September and October, in water two to four feet in depth; the ova are eaten by the

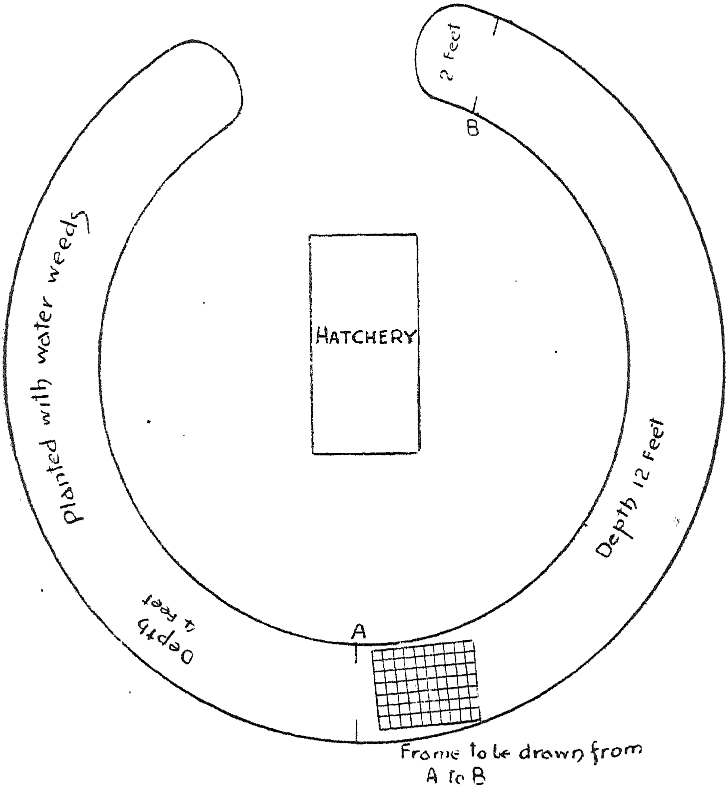
"Grunter." Therapon percoides and other fish; some few being hidden in the weeds, escape detection; I believe in thick masses of Hydrilla they have the best chance. On Nitella beds, the ova that sink deep perish owing to the lower portion of the Nitella being in a state of decomposition; the eggs that reach the sand or mud also die, probably from this being foul. The eggs that get tangled up in the green weeds and not exposed to too much light develop in about a month; the larvæ of insects seem not to injure them but are attracted by the young fish directly it emerges.

A dredging net made of mosquito net on a stout ring of iron is serviceable in scooping through the weeds in search of ova: the ova must be kept cool and in the dark; they are very easily killed; only a few obtained in this rough way develop. It is absolutely necessary to keep the newly hatched fish in the dark for a week at least.

Control experiments with the ova of the common Cat-fish, Tandanus tandanus, were very successful under the conditions that seemed the reverse for Ceratodus; a young Tandanus might be likened to the chick of the common fowl and Ceratodus to a young pigeon.

One experienced in rearing trout would be required to attend to the hatchery.

Proposed Artificial Lagoon for Observations on Ceratodus; possibly too on Scleropages Leichhardti and the Platypus.



PROCEEDINGS

OF THE

Annual Meeting of Members,

Held on Saturday, February 25th, 1911.

The Annual Meeting of the Society was held on Saturday, February 25th, 1911. The President (Mr. W. R. Colledge), occupied the chair. The minutes of the previous Annual Meeting were read and adopted.

The Hon. Secretary (Mr. F. Bennett), read the following Report of the Council for the year 1910 :—

To the Members of the Royal Society of Queensland.

Your Council have pleasure in submitting their Report for the year 1910.

The ordinary monthly meetings have been held as shown in Appendix B.

Eleven Council meetings have been held during the year, at which the attendance was as shown in Appendix A.

During the year 11 new members and nine honorary and corresponding members were admitted, and we lost by death, removal, or resignation, 8 members. We have to regret the loss of J. G. Collins, Esq., of Mundoolan. A letter of condolence was sent to the surviving relatives of this worthy pioneer. On Lord Chelmsford's departure to New South Wales, His Excellency Sir Wm. MacGregor was chosen Patron. There are now on our roll 91 ordinary members, 13 corresponding members, and 1 associate member, a total of 105. See Appendix D.

Of the corresponding members, J. H. Maiden, F.L.S. ; H. I. Jensen, D.Sc. ; Rev. G. Brown, D.D. ; A. Gibb-Maitland, Drs. Domin and Danes, and Professors Skeats, Rennie, and Pollock were enrolled during the past year.

The Hon. A. J. Thynne was elected Trustee in the place of Dr. John Thomson, deceased. Mr. E. H. Gurney

was elected Vice-President in March, and Mr. Weston took Mr. Gurney's place on the Council ; Mr. G. Watkins again accepting the position of Hon. Auditor.

The Council notes with pleasure the honour accorded to one of our members, F. M. Bailey, Esq., F.L.S., in creating him C.M.G. This appreciation of a life time of devotion to Botanical Science must be viewed with satisfaction by all scientists.

Part II. of Vol. XXII. of our Proceedings was issued during the year.

The papers for last year have added largely to our record of original research, and the forthcoming volume of Proceedings will be one of the bulkiest and most valuable, scientifically, that we have issued.

An attempt was made to let authors have their author's copies as soon as possible after the delivery of their papers, and our printers have done their best to help.

The early inception of the University should give a decided impetus to scientific research.

Our Library is almost too large for the space at our disposal, and keeps growing. Some interesting publications on Malaria Prevention were received, in answer to our requests, from the Health Departments and experts of the world. When the permanent location of the Library is fixed, it will be wise to bind a large mass of valuable matter still unbound.

By Appendix C, it will be seen that receipts for the year exceeded expenditure by £27 0s. 5d. The credit balance at the end of 1908 was £9 2s. 6d. ; at the end of 1909, £22 12s. 4d. ; and at the end of 1910, £49 12s. 9d.

F. BENNETT,
Hon. Secretary.

W. R. COLLEDGE,
President.

Brisbane, February 25th, 1911.

APPENDIX A.

Office.	Name.	Council Meetings—11	Special Meetings—0	Remarks.
President ..	W. R. College	8		
Vice-President ..	E. H. Gurney	7		
Hon. Treasurer	J. C. Brünnich, F.I.C. ..	6		
Hon. Secretary..	F. Bennett	11		
Hon. Librarian	C. T. White	10		
Members of Council.	J. B. Henderson, F.I.C. ..	8		
	J. Shirley, B.Sc.	2		
	W. R. Parker, L.D.S. ..	4		
	P. L. Weston, B.Sc., B.E.	4		Appointed in March.

APPENDIX B.

List of Papers Read During 1910.

No.	Date.	Title.	Author.
1	Feb. 26	Introduction of Economic Plants into Queensland (Presidential Address)	J. F. Bailey
2	Mar. 3	"Melanesians and Polynesians." Lecture.	Revd. G. Brown, D.D.
3	April 9	Notes on the Phyto-Geography of Queensland	Prof. K. Domin (Univ., Prague)
4	May 28	Rotifers of Queensland ..	W. R. Colledge
5	July 23	The Physiography of Certain Limestone Areas in Queensland	Prof. Danes (Univ., Prague)
6	Aug. 26	" The Weathering of Building Stone and its Prevention "	H. C. Richards, M.Sc.
7	Sept. 24	(1) Additions to the List of Marine Mollusca in Queensland	J. Shirley, B.Sc.
		(2) A Bora Ring in the Albert River Valley	J. Shirley, B.Sc.
8	Oct. 29	Geological and Biological Notes of the Nerang District, illustrated with Diagrams and Specimens	Prof. S. B. J. Skertchly
9	Nov. 26	Anthropological Observations among the Blacks of 60 years ago	R. Cliffe-Mackie

APPENDIX C.

THE ROYAL SOCIETY OF QUEENSLAND.

FINANCIAL STATEMENT for the Year 1910.

Dr. **Cr.**

RECEIPTS.

	£	s.	d.
To Balance from last Report	22	12	4
,, Subscriptions	78	4	0
,, Sundries	0	0	3
	£100	16	7

DISBURSEMENTS.

	£	s.	d.
By Printing (Pole & Co.)	27	6	0
,, Postage, Monthly Notices	4	19	1
,, Advertising Meetings	1	17	6
,, Postage of Proceedings	1	7	6
,, Librarian's Postage	0	11	1
,, Shifting Library	1	0	0
,, Freight	0	8	0
,, Insurance	1	2	6
,, Petty Cash, General Postage, &c.	6	3	2
,, Rent	3	0	0
,, Caretaker to June	0	10	0
,, Rent, &c. of Albert Hall (Dr. Brown's lecture) ..	1	11	6
,, Lamp	0	12	6
,, Cheque Book	0	5	0
,, Bank Charges	0	10	0
,, Balance	42	12	9
	£100	16	7

J. C. BRÜNNICH, *Hon. Treasurer.*

Examined and found correct,

GEO. WATKINS, *Hon. Auditor.*

Brisbane, 31st January, 1911.

APPENDIX D.

LIST OF MEMBERS.

Honorary and Corresponding Members.

Dr. Cockle; Rev. Robt. Harley, M.A., F.R.S., F.R.A.S.; A. Liversidge, F.R.S., F.C.S., F.G.S.; Rev. F. R. M. Wilson; J. H. Maiden, F.L.S.; H. J. Jensen, D.Sc; Rev. G Brown, D.D.; A. Gibb-Maitland, Government Geologist, W.A.; Professor E. W. Skeats; Professor E. H. Rennie; Professor J. A. Pollock; Dr. K. Domin, University, Prague; Dr. Danes, Prague University.

Ordinary Members.

Archer, R. S.
Badger, J. S.
Ball, L.C., B.E.
*†Bailey, F. M., F.L.S., C.M.G.
†Bailey, J. F.
Bennett, F.
Brünnich, J. C., F.I.C.
Brydon, Mrs.
Bundock, Miss Alice
Bundock, C. W.
Byram, W. J.
Cameron, John
Cameron, W. E., B.A.
Colledge, W. R.
Collins, Miss Jane
Collins, R. M.
Connah, F. E., F.I.C.
Cooper, Sir Pope A., C.J.
Costin, C. W.
Cowley, R. C.
Dempsey, J. J.
Dodd, S., F.R.C.V.S.L.
Dunstan, Benj.
Eglinton, Dudley
Eglinton, Miss Hilda
Elkington, J. S. C, M.D., D.P.H.
Forrest, E. B., M.L.A.
Fraser, C. S.
†Gailey, Richard
Gibson, Hon. A., M.L.C.
Gore-Jones, E. R.
Greenfield. A. P.
*†Griffith, Sir S. W.
Gurney, E. H.
Hedley, C., F.L.S.
Henderson, J.B., F.I.C.
Hirschfeld, Eugen, M.D.
Holland C. W.
Hopkins, G., M.D.
Hülsen, R.
Hunt, G. W.
Illidge, Rowland
†Jack, R. L., L.L.D., F.G.S., F.R.G.S.
Jackson, A. G.
Johnston, Jas.
Jones, P. W., A.I.C.
Lindsay, W.
Lord, F.
Love, Wilton, M.B.
Lucas, T. P., L.R.C.P.
His Excellency Sir William MacGregor, M.D., D.Sc., G C.M.G. C.B., &c
Mackie, R. Cliffe
Marks, Hon. C. F., M.D., M.L.C.
Marks, E. O., B.A, B.E.
May, H. W., B.E.
May, T. H., M.D.
Miles, Hon. E. D, M.L.C.
Murray-Prior, Mrs.
McCall, T., F.I.C.
McConnel, Eric W.
McConnel, E. J.
McConnel, J. H.
Morris, L., A.M.I.C.E., Eng.
†Norton, Hon. A., M.L.C.
Parker, W. R., L.D.S.
Plant, Hon. E. H. T., M,L.C.
Pound, C. J., F.R.M.S.
*Raff, Hon. Alex, M.L.C.
Rands, W. H., F.G.S.
Reid, D. E.
Richards, H. C., M.Sc.
Riddell, R. M.
†Roe, R. H., M.A.
Ryan, J. P., M.D.
Sankey, J. R.
†Schneider, H., M.A.
Shirley, J., B.Sc.
Silcock, P.
Smith, F., B.Sc., A.I.C.
†Steele. T., F.L.S., F.E.S.
†Stevens, Hon. E. J., M.L.C.
Sutton, A., M.D.
†Sutton, J. W.
Taylor, Hon. W. F., M.D., M.L.C.
Thynne, Hon. A. J., M.L.C.
Tonks, T.
Turner, A. Jefferis, M.D.
Watkins, Geo.
†Weedon, Warren
Weston, P. L., B.Sc., B.E.
Willcocks, G. C.

Associate Member.

White, C. T.

*Members of Philosophical Society. †Life Members.

The adoption of the Report was moved by the Hon. A. Norton, seconded by Mr. J. F. Bailey, and carried.

The Financial Report was moved by the Hon. Treasurer (Mr. J. C. Brünnich), seconded by the Hon. W. Taylor, and carried.

The following office-bearers for 1911 were elected :— President, J. Brownlie Henderson F.I.C. ; Vice-President, P. L. Weston, B.Sc., B.E. ; Hon. Treasurer, J. C. Brünnich, F.I.C. ; Hon. Secretary, F. Bennett ; Hon. Librarian, C. T. White ; Council, Messrs. W. R. Colledge, E. H. Gurney, and H. C. Richards, M.Sc. ; Hon. Lanternist, A. G. Jackson ; Hon. Auditor, Geo. Watkins.

The retiring President (Mr. W. R. Colledge) then installed Mr. Henderson in office. Mr. Henderson called on Mr. W. R. Colledge to deliver his Presidential Address. Mr. Colledge, in his prefatory remarks, announced the issue of a bulky volume of Proceedings, and commented on the indefatigable industry of the Hon. Secretary in obtaining Papers.

The Lecture was illustrated by many fine slides, the lantern being ably operated by Mr. A. G. Jackson.

Professor Skertchly moved, Mr. F. Bennett seconded, and Prof. Watson, of Adelaide, supported a vote of thanks to Mr. Colledge for his Presidential Address.

PROCEEDINGS

OF THE

Annual Meeting of Members,

Held on Monday, March 25th, 1912.

The Annual Meeting of the Society was held in the Queensland University, Monday, March 25th, 1912. The President (Mr. J. B. Henderson) occupied the chair. There was a very fair attendance of Members and friends, including His Excellency, Sir Wm. Macgregor, Lady Macgregor, and Mr. Byth (Private Secretary). The minutes of the previous annual meeting were read and confirmed. The Hon. Secretary read the accompanying Report for the year 1911, which was adopted on the motion of Mr. J. F. Bailey, seconded by Mr. E. C. Barton. The Financial Report (as herewith) was moved by Mr. J. C. Brunnich (Hon. Treasurer), seconded by Mr. A. G. Jackson, and carried.

To the Members of the Royal Society of Queensland.

Your Council have pleasure in submitting their Report for the year 1911

The Ordinary Monthly Meetings have been held as shown in Appendix B.

Eleven Council Meetings have been held during the year, at which the attendance was as shown in Appendix A. At no meeting was there an attendance of fewer than five Councillors.

During the year 10 members were admitted, and we have lost by removal and other causes, 6 members. There are now on the roll 14 honorary and 95 ordinary members, a total of 109. See Appendix D.

Messrs. Bailey and Jackson were selected in March to fill the vacancies on the Council, Mr. G. Watkins again accepting the position of Hon. Auditor.

Vol. XXIII of our proceedings was issued during the year. A number of papers of considerable value were

given during 1911, especially in the fields of Geology and Biology, and the forthcoming volume promises to be one of value. Plates will be more in evidence than in years when less funds were available. Our printers do their best to let each author have his author's copies as soon as possible after the M.S.S. is handed in, and each author is now allowed 50 author's copies. We have received valuable help from several members of the University staff, and have reason to hope that, when matters have passed the difficulties of the inception stage, and when science students are more numerous, we shall receive for publication much research work from the University and its alumni.

The Library, containing approximately 4,000 volumes, has been shifted from the Technical College to the University. This has entailed considerable expense, and as it is now imperative that we should bind much unbound work, a further expense will be entailed. This, with the cost of a well illustrated volume of Proceedings, will lower our Bank balance during the year ahead of us. We congratulate our members on meeting for the first time in the University, and trust that the Society's valuable Library will be largely made use of by members and University students in the future. It is hoped that Dr. Harvey-Johnston will take charge of the receipt of exchanges, etc., while the issue of books will be under the control of the University Librarian, and thus both our and the University's interests will be seen to.

By Appendix C., it will be seen that, though there was an increase in expenditure of about £43 for printing Proceedings, we still have a slightly greater credit to balance than we had at the end of the previous year.

F. BENNETT, *Hon. Secretary.*

J. B. HENDERSON, F.I.C. *President.*

February, 1912.

APPENDIX A.

Attendance of Council, 1911.

Office.	Name.	Council Mt'gs—11	S'p'l C'cil Mt'gs—1	Remarks.
President ..	J. Brownlie Henderson, F.I.C.	10	1	
Vice-President ..	P. L. Weston, B.Sc., B.E.	5	—	
Hon. Treasurer..	J. C. Brünnich, F.I.C. ..	8	—	
Hon. Secretary..	F. Bennett..	11	1	
Hon. Librarian..	C. T. White	7	1	
Members of Council	E. H. Gurney	7	1	
	W. R. Colledge	9	1	
	H. C. Richards, M.Sc ..	7	1	
	J. F. Bailey	3	—	Appointed in March.
	A. G. Jackson	2	1	

APPENDIX B.

List of Papers, Etc., Read During 1911.

No.	Date.	Title.	Author.
1	Feb. 25	A Brush-Tongued Mosquito (Presidential Address)	W. R. Colledge.
2	March 25	Anthracite in Galena	L. C. Ball, B.E.
		Exhibits of Galena of peculiar character	H. C. Richards, M.Sc.
		New Slides	J. F. Bailey.
	April 25	Exhibition of Chemical Apparatus by Government Analyst and Staff	
3	June 24	Notes on the Geological Age of Volcanic Activity in South-east Queensland	E. O. Marks, B.A., B.E
4	July 29	The Building of Eastern Australia	H. I. Jensen, D Sc.
5	Aug. 26	The Building Stones of St. John's Cathedral, Brisbane	H. C. Richards, M.Sc.
6	Oct. 28	On the Occurrence of Worm-nests in Cattle	T. Harvey-Johnston, D.Sc.
7	Oct. 28	A Census of Australian Reptilian Entozoa	T. Harvey-Johnston, D.Sc.
8	Dec. 2	A Weak Point in the Life History of a Ceratodus	Dr. Thos. Bancroft.

APPENDIX C.

THE ROYAL SOCIETY OF QUEENSLAND.

FINANCIAL STATEMENT for the Year 1911.

Dr. **Cr.**

RECEIPTS.	£	s.	d.
To Balance from last Report	49	12	9
,, Subscriptions, etc.	82	8	1
,, Postage on Proceedings not required	1	10	6
	£133	11	4

DISBURSEMENTS.	£	s.	d.
By Printing (Pole and Co.)	60	3	0
,, Postage of Monthly Notices	2	18	0
,, Postage of Proceedings	4	0	0
,, Librarian's Postage	0	11	4
,, Insurance	1	2	6
,, Petty Cash and General Postage	5	11	11
,, Rent and Caretaker to December, 1911	3	0	0
,, Bank Charges	0	10	0
,, Cartage	0	10	0
Balance	55	4	7
	£133	11	4

Examined and found correct.

GEO. WATKINS, *Hon. Auditor.*

J. C. BRÜNNICH, *Hon. Treasurer.*

Brisbane, 2nd February, 1912.

APPENDIX D.

LIST OF MEMBERS.

HONORARY AND CORRESPONDING MEMBERS (13.)

Dr. Cockle; A. Liversidge, F.R.S., F.C.S., F.G.S.; Rev. F.R. M. Wilson; J. H. Maiden, F.L.S.; H. J. Jensen, D.Sc; Rev. G Brown, D.D.; A. Gibb-Maitland, Government Geologist, W.A.; Professor E. W. Skeats; Professor E. H. Rennie; Professor J. A. Pollock; Dr. K. Domin, (Czech University), Prague; Dr. Danes (Czech University), Prague; Professor T. Edgeworth David.

ORDINARY MEMBERS (95).

Archer, R. S.
Badger, J. S.
Ball, L.C., B.E.
*†Bailey, F. M., F.L.S., C.M.G.
†Bailey, J. F.
Barton, E. C.
Bennett, F.
Brünnich, J. C., F.I.C.
Brydon, Mrs.
Bundock, Miss Alice
Bundock, C. W.
Byram, W. J.
Cameron, John
Cameron, W. E., B.A.
Colledge, W. R.
Collins, Miss Jane
Collins, R. M.
Connah, F. E., F.I.C.
Cooper, Sir Pope A., C.J.
Costin, C. W.
Cowley, R. C.
Dempsey, J. J.
Dunstan, Benj.
Eglinton, Dudley
Eglinton, Miss Hilda
Elkington, J. S. C., M.D., D.P.H.
Forrest, E. B., M.L.A.
Fraser, C. S.
†Gailey, Richard
Gibson, Hon. A., M.L.C.
Gore-Jones, E. R.
Greenfield. A. P.
*†Griffith, Sir S. W.
Gurney, E. H.
Hamlyn-Harris, R., D.Sc., F.R.M.S., F.L.S., F.E.S.
Hedley, C., F.L.S.
Henderson, J. Brownlie, F.I.C.
Hirschfeld, Eugen, M.D.
Holland C. W.
Hopkins, G., M.D.
Hülsen, R.
Hunt, G. W.
Illidge, Rowland
†Jack, R. L., L.L.D., F.G.S., F.R.G.S.
Jackson, A. G.
Johnston, T. Harvey, M.A., D.Sc., F.L.S.
Johnston, Jas.
Jones, P. W., A.I.C.
Lindsay, W.
Lord, F.
Love, Wilton, M.B.
Lucas, T. P., L.R.C.P.
His Excellency Sir William MacGregor, M.D., D.Sc., G.C.M.G. C.B., &c
Marks, Hon. C. F., M.D., M.L.C.
Marks, E. O., B.A., B.E.
May, H. W., B.E.
May, T. H., M.D.
Michie, J. L, M.A.
Murray-Prior, Mrs.
McCall, T., F.I.C.
McConnel, Eric W.
McConnel, E. J.
McConnel, J. H.
Morris, L., A.M.I.C.E., Eng.
†Norton, Hon. A., M.L.C.
Parnell, T, M.A.
Parker, W. R., L.D.S.
Plant, Hon. E. H. T., M.L.C.
Pound, C. J., F.R.M.S.
Priestley, H. J., M.A.
*Raff, Hon. Alex, M.L.C.
Rands, W. H., F.G.S.
Reid, D. E.
Richards. H. C., M.Sc.
Riddell, R. M.
†Roe, R. H., M.A.
Ryan, J. P., M.D.
Sankey, J. R.
Saunders, G I., B.E.
Schild, S. D., A.S., A.S.M. (Adelaide)
†Schreider, H., M.A.
Shirley, J., B.Sc.
Smith, F., B.Sc, A.I.C.
†Steele, T., F.L.S., F.E.S.
Steele, B. D., D.Sc.
†Stevens, Hon. E. J., M.L.C.
Sutton, A., M.D.
†Sutton, J. W.
Swanwick, K. ff., B.A., L.L.B.
Taylor, Hon. W. F., M.D., M.L.C.
Thynne, Hon. A. J., M.L.C.
Turner, A. Jefferis, M.D.
Watkins, Geo.
†Weedon, Warren
Weston, P. L., B.Sc., B.E.
White, C. T.
Willcocks, G. C.

*Members of Philosophical Society. †Life Members.

Nine admitted. Six left colony or resigned. Now on list, 109.

The following new members were proposed by Mr. H. C. Richards, M.Sc. :—A. W. Oakes, B.A., S. G. Lusby, M.A., H. G. Denham, D.Sc., and P. P. Fewings, Esq.

The President then delivered his Retiring Address.

PRESIDENTIAL ADDRESS.

National Waste.

It is only six years since I previously had the honour of presiding over the deliberations of our Society, and I then took for the subject of my address, one in which we all have long taken a considerable interest—Education. I then called attention to the pressing necessity for the influence of a University on our national life, and we are now in the happy position of having achieved our hearts' desire in that direction, and to-night the Royal Society meets for the first time within the University Building. It is true that it is but an infant among Universities, but it is an infant whose growth has already seriously embarrassed its parents. The baby has completely outgrown its clothes, and judging by this remarkable growth and the preparations proposed for its further expansion, it is going to grow much more quickly than provision has been made for clothing it. And where the money is to come from to feed it as it grows, is already a pressing question, and one that has to be looked at from two different standpoints—that of the young Queenslanders demanding a first class up-to-date education such as will fit them to be capable leaders of this great State, and that of the State Treasurer who has to find the money. Let us hope that Queenslanders will see that the best education that can be had is not too good for the best of our young men and women, and that they will give at election times a mandate to their Parliamentary representatives that education, primary, secondary and University, is *the* most important part of the national life which is dealt with by our system of Government, and must be made efficient. Primary education is already well in hand, secondary and University education are only in their infancy, and must be as carefully nourished and as freely fed as our splendid system of primary education.

Nearly everything has been done for our University so far by the Government ; in the Southern States, the three older Universities have had almost as much done for them by private benefactors as by Government aid. It is to be hoped that Queensland will not long remain distinguished as purely a Government University. Already a few thousands have been given, but hundreds of thousands are required for endowment. It is not generally realised that it takes nearly £25,000 to endow the professor's salary for any one chair, apart from the cost of lectures, laboratories and other incidental expenses. Sydney has private endowments amounting to about £500,000, and we must provide at least as good an education as Sydney, if our students are to hold their own in after life.

In thinking over possible subjects for my address this evening, I decided to follow up one which must have repeatedly thrust itself on the attention of every student of science—the national waste of material, of energy, and even of life itself that is going on around us in every direction.

It is quite true that we are a young nation, we have only passed our Jubilee, and that youth is the time of waste. It is only on reaching maturity that the individual apprehends the necessity of conserving energy, and nations are apt to resemble the individuals of which they are mostly built. But, after all, a nation is guided (or should be guided), by individuals of mature thought, by men who have (or should have), the large outlook and who should never hesitate to spend or be spent in the effort to help every individual to get the best possible return for his work, and to advance the nation to the highest, morally, mentally and materially.

My object to-night is to point out briefly some of the directions in which we are wasting materials and energy —and energy means wealth, and in its final application, life. I found when I opened up the subject that it led to much labour, much searching—that many hours spent in looking for information and statistics gave little result, and that the most I could hope for was to interest a few who had more leisure to take up some branches of this subject and investigate them thoroughly.

Considering the enormous wealth produced by our handful of people, it may seem absurd to talk of national waste. Let us glance at some of our industries as they stand to-day, and see if after all we are not wasting golden opportunities.

Take first of all our Pastoral Industries. Wool is one of our principal exports. In 1910, the wool exported was valued at £5,808,000 and weighed 139,250,802lbs. (Government statistician). Much of this was scoured, and most of it could easily have been scoured here. In France it pays to extract the water-soluble potash salts from wool by washing the wool with cold water and evaporating the solution. From 7.0 to 10.0 per cent of potash salts is obtained in this way from raw wool. (F. H. Bowman's "Wool Fibre," page 256). We produced over 139 million pounds weight of raw wool in 1910, containing over 6,000 tons of potash salts recoverable without damaging the wool, obtained by washing with water. The evaporation of this solution in the dry atmosphere of West Queensland should not be an expensive matter. We are evidently losing wealth in that direction.

Wool again is the source of lanoline, which exists in raw wool to the extent of about 14 per cent. So far as I can gather no lanoline is saved in Queensland. So we throw away every year 20 million lbs. weight of lanoline. And the German wholesale price of lanoline is about 11d. per lb. I do not mean the mixture of lanoline, vaseline and water, which is sold as lanoline in collapsible tubes, at a very much higher rate. But at 11d. per lb. our lanoline which we threw away in 1910 had a value of approximately £1,000,000. Personally I think there is certainly a fair margin of profit showing here—it is not at all likely that a process which is already worked successfully and well known in Germany, would cost a great deal more to work here, with such a store of raw material to hand.

Other directions in which it is obvious that waste might be avoided and energy and material conserved in the pastoral industry, are preservation and care of natural pastures, and the prevention of spread of weeds and other vegetable pests. The danger of practically exterminating some of our most valuable indigenous pasture grasse

and herbs has repeatedly been pointed out, but the temptation to overstock pastures in good seasons is always present, and the danger is one which it is difficult to overcome, either by legislation or administration. The annual loss of animal life from poisonous weeds is very heavy and in some cases might be avoided. The loss of pastures, through overgrowth of weeds, is almost invariably easily prevented, as in the case of prickly pear, but when lost, the cost of recovery of the pasture is exceedingly heavy. It has been pointed out repeatedly that the spread of cattle ticks, which have wasted millions of money, might have been prevented when first noticed in Northern Queensland; now they are evidently here to stay, and they demand an annual toll running into many thousands of pounds. It probably costs Queensland much more every year for feeding the ticks with cattle than for all the secondary and University education combined.

Another of our great Industries is the production of sugar. In 1910 we produced 210,756 tons of sugar (Government Statistician). Now each ton of sugar means the production of about 35 gallons of molasses, so that 7,376,000 gallons of molasses were produced. Nearly all of that was wasted; so far as I can learn only a very small proportion was made into cattle feed and not much converted into alcohol. Each gallon of molasses yields about 0.4 gallon of alcohol so that molasses sufficient to make nearly 3,000,000 gallons of alcohol was thrown away to become a nuisance to whole neighbourhoods. The importation of petrol to Queensland in 1911 was 765,139 gallons which, at 1s. 4d. per gallon, gives £51,000. Evidently most of the money sent from here to America for petrol might have been kept in Queensland. I understand that alcohol cannot be bought in Queensland at less than 1s. 5d. per gallon. Three million gallons at 1s. 5d. represents £212,500, a considerable annual loss to the state. It is possible even now to sell industrial alcohol at 1s. 3d. per gallon in Queensland. Unfortunately the stringent Excise Laws add materially to the cost and trouble of using industrial alcohol, owing to the fear that some of our decadent and debased fellow citizens might drink alcohol which had paid no duty. But for that fear, industrial

alcohol could be sold at 1s. per gallon, possibly lower, and at that price it would probably replace kerosene and largely replace petrol.

I would note here that profitable undertakings, considered from the national and from the trading company standpoint do not necessarily mean the same thing. A trading company with income and expenditure balancing is a financial failure—a nation with income and expenditure balancing is a financial success. The production of alcohol from molasses, to replace petrol, if it only paid expenses from a trading standpoint might not be profitable—from the national standpoint there would be one saving among others, of £51,000 which would otherwise have gone to America. In other instances which I note, I obviously do not intend to suggest that the value of the material at present wasted would be all profit to the trader—but that that value is a value lost to the nation. Whether from the standpoint of National Economics, it would pay to keep an industry going which only paid expenses, is a question which it is not necessary at present to discuss —in most of the instances I have given, the wastes are already being made sources of trading profit elsewhere.

The enormous quantity of megass which is burned in the sugar mills is often looked on as waste, and many suggestions have been made as to its better utilisation as in making paper, paper pulp, etc. I understand that no use has yet been found for this material which will give a greater return than its use as fuel, so at present it cannot be looked on as wholly a wasted product.

In agricultural products, other than sugar, there is also a lavish waste of wealth. After good seasons, hundreds of thousands, probably millions, of tons of grass are burned off which might have been stored for fodder, either dry in stacks or as ensilage in silos.

I remember a former Under Secretary for Agriculture telling me that in one district shortly after the great drought which ended in 1902, he saw several farmers throw into the roadways alongside, lucerne which they had cut—it was so low in price just then that it would not pay to send to market. And yet a few months later lucerne had

again risen in price and stacked lucerne would have returned many times the cost of stacking. Five years ago the Government fruit expert published the fact that in the Cleveland district alone 300 tons of mangoes were allowed to go to waste—it did not pay to market them As old trees yield from 1 to 2 tons of fruit in a good season, it is evident that thousands of tons of mangoes go to waste in Queensland every good season.

There is something seriously wrong with the people of a country in which superabundant wealth of agricultural products is produced in a good season, only to be to a large extent deliberately wasted, and who cry out with pangs of starvation after one dry year. Surely with all our education and training and our agricultural experts, it will not much longer be left to sad personal experience, the most costly of all teachers, to teach many of those engaged in agriculture the necessity of making the good seasons provide for the bad.

A most serious blot on our national life is the primitive and wasteful manner in which we are attempting to settle people on our lands. The sacred right of individual liberty has, in this case, been carried to an absurd extreme. It is still true " none of us liveth to himself." The State recognises not only the right of the individual to a certain amount of freedom, but on the other hand insists that as he is a part of the State he must not damage the State by, for instance, destroying himself. Where the freedom of the individual undoubtedly and seriously conflicts with the good of the State that freedom should certainly be curtailed. Nothing can damage our State more seriously than to have men throwing away their substance and the best of their lives attempting impossible tasks in pioneering. And yet it is not many years since I heard of a family of new arrivals from England, with only £50 capital, being allowed to take up prickly pear land. The result was a foregone conclusion—they held out until starved out and then abandoned the hopeless task. Most of us in travelling over Queensland have seen the remains of not one or two, but of hundreds of abandoned homes, most of them representing a waste of capital and life which can be ill-spared in our vast territory, and which a little more knowledge

would have prevented—knowledge too, which was possessed by officers in the Lands Department from which the selections were taken. But, owing to the fact that it has hitherto been regarded as the absolute right of every man to "do what he likes with his own," selectors have been and still are permitted to undertake the task of establishing homes on lands where it is perfectly obvious that the applicants, owing to lack of capital, or experience, or both, must certainly fail. In doubtful cases by all means let the applicant try, but when he asks for land where he obviously cannot succeed, do not give it to him—persuade him to take some where he has at least a fighting chance. It is perfectly obvious that the settler who can start on land which is ready for planting, or which will in some way yield him a return for his labour in a short time, is almost bound to succeed. Settlers who tackle pioneering are generally hard-workers, and if success is to be obtained by constant application, they will succeed. It is also perfectly obvious that in many cases, the first clearing work could be done much more economically by the Government with its command of large capital, for large machinery, than it could be done by the selector with his one-man efforts.

Most of us have seen, or know of, thousands of square miles of our Western Country, already fairly well served by railway, which if cleared of prickly pear or scrub, or both, ploughed where necessary, and made ready for the farmer to begin work, would be instantly snapped up by farmers. But the first cost of this preliminary work makes it practically impossible for the average farmer to attempt the task with any chance of success. I am quite certain that before many years are over, we will find the State Governments of Australia doing this pioneering work as a matter of course, even as they now undertake for the individual the administration of justice, of defence, the post and telegraph, roadmaking, and all those other services which civilised communities have found to be better undertaken by the community than by the individual. The State which leads the way by preparing the land and the railway to market, so that success in settling on new land will be practically assured instead of being exceedingly problematical, will not lack increase of population. Immigrants would flock in by thousands to obtain such a chance, while

the cost to the State of doing the pioneering would easily and certainly be repaid by the increased value of the land. Good agricultural land is one of the few assets which seems never to fall in value—as the population increases the value of such land also increases. The unnecessary waste of time and capital and life in the single handed and other ignorant methods of our pioneers, is probably one of the most serious wastes in our national life. It means not only time and capital gone—the crushing, physical strain often lowers the worker almost to the level of a working animal. He is up before daybreak, toils all day, often till long after dark, and if he is dairying, keeps it up for seven days a week. There is no time for reading, none for thinking, none for recreation, only one long struggle to achieve the goal of an independent living. But in the struggle, even when successful, there is too often almost as much lost as is gained. Even years after success has been attained from the material point of view, there is often still no flower garden, no library in the house holding the treasures of the ages, no work of art worthy of the name, and the only music heard is a thing to be avoided. I have even known such a one living in the old tumble-down slab humpy, with all its crudities, inconveniences and ugliness, with no garden, no attempt at bettering in any way the material surroundings, and yet, in a well-finished building close by, a beautiful up-to-date motor car. So common is this loss among the farmers of much that is best and noblest and highest in our lives, that the suggestion that a higher standard is possible, is often received with incredulous smiles. Such words as "bucolic" and "bumpkin" convey meanings not at all complimentary to farmers. But history also teaches that from the farm have come great leaders of thought, soldiers, scientists, even artists—in a word, the past declares that there is nothing in farming that should lead to the atrophy of our higher nature. In the present each one of us knows of families on the farm where, along with the ability to work hard and successfully, goes a refinement and education, which is as genuine and thorough as could be met with in any city home. The frequent loss of many of those higher attributes which distinguish man from the lower animals, in the terrible struggle for his animal existence in a new land, or for that matter in

an old land, is a serious form of national waste that undoubtedly saps the strength of any country. Anything that can be done by a Government, that is by the community, to lighten that load and more quickly bring the settler to obtaining a livelihood without such extremes of wasteful toil, it is the imperative duty of that Government to do, and it can be done without going to the other extreme of sapping the individuality of the farmer. The problem is obviously one which can be successfully financed. The actual details of the methods by which the work should be done would vary with circumstances, but would give by no means impossible problems to a properly qualified agricultural engineer. It is rather a notable fact and typical of the state of our agricultural methods that although nearly three-fourths of our exports are of agricultural origin, agricultural engineers are practically unknown in Queensland.

There are other directions in agriculture in which there is at present a great waste of energy and material, such as the burning off of millions of feet of timber when clearing, because no one can find a use for it.

The waste of Forestry has been and still is, appalling, but I can find no statistics available.

Water, both rainfall and artesian, is mostly run to waste.

Then there is the use of horse ploughs for large areas where steam or petrol would be much less costly, and similar primitive methods of working. I noticed recently a statement by a Manitoba wheat farmer, that the replacement of horses by a large petrol tractor for ploughing and reaping had saved him £500 a year. Where capital is not available to small farmers for the purchase of such expensive engines, there is a good opening for co-operation.

Turning for a moment to the Mining Industry, we find there a similar prodigality in wasting our mineral wealth. The history of many mining companies is a succession of managers, each of whom points out that his predecessor knew nothing of his business, and straightway proceeds to demonstrate that he also does not know how to solve the problems. And so we have the capital which should have been applied to making the mine a

wealth-producing business, squandered in useless and often absurd methods. As an example of the results which can be achieved by educated endeavour in our mining methods, take one of our largest well-known Northern mines. There, where everything pointed to disaster, a qualified engineer, a university graduate, was appointed. He reduced the costs by over 20s. per ton on an output of about 20,000 tons per annum, and so turned a dismal failure into a dividend paying mine.

Lying in many places over Australia, including Queensland, are huge heaps of ore residues, all waste products. They contain hundreds of thousands of pounds worth of metallic values, but for the lack of a little knowledge—knowledge of a proce.,s which would economically extract these values, all of that wealth at present lies waste.

From one works alone (Mt. Morgan), over 800 tons of sulphuric acid per day is thrown away into the atmosphere. This enormous loss is much more marked in America than it is here, and the problem of its utilisation is receiving close attention there.

In our coal mining also, the great bulk of our wealth of coal is wasted. First of all, with present mining methods, about one-third of the coal is left in the seams, and can never be recovered. Of what is extracted that used in producing power by steam is mostly wasted—some of the waste being inherent to the methods, much of it due to unsuitable boiler construction, dirty tubes and plates, and bad firing. It has been estimated that of the energy actually obtained from the original coal in a coal seam, less than 10 per cent is utilised by steam engines. With house coal for heating and cooking, matters are even worse, probably less than 1 per cent of the original energy of the coal seam being utilised.

There is one obvious method of effecting a huge saving in this wasteful method of producing energy, a method to which attention has been called elsewhere. It is to establish a huge power station at the centre of the mining district—in our case, near Ipswich. There electrical power would be generated from waste coal and from the waste gases from large coking ovens. The by-products rom the distillation of the coal would also yield a return

in ammonia, phenols, etc. Electric power generated on a large scale from such waste fuel would, according to the estimate of one of my engineering friends, cost not more than 0.4d. per unit. From Ipswich, it could be distributed all over the Ipswich and Brisbane districts at a cost that would put electric light, electric power, and electric heating into every home. With modern metallic filament lamps, electric light is already a competitor with gas; and at such a low rate for electricity, it would at once displace gas for lighting, as much cheaper, more sanitary, more convenient; in fact, better in every way. I made an attempt to get actual figures as to the probable saving to Brisbane by the adoption of this form of utilisation of the energy of our coal supply, including cost of capital outlay, but statistics and facts were difficult to get, while some necessary factors in the calculation seem almost unobtainable, and they should certainly be handled by an engineer. However, a presidential address is not supposed to concern itself with direct original research, so I will leave the detailed elucidation of this subject to one of our engineering members: more than one good paper could be written on the subject. But I have found enough to justify the statement that the saving would be enormous, both to energy users in cost, and to the reserves of coal.

For example, of the heat produced in cooking at an ordinary stove, probably less than 2 per cent is actually utilised, I can find no statistics of trials, though I understand they have been made. But in electrical cooking, from 70 per cent to 80 per cent of the energy is actually utilised. With a low price for electricity the saving would be marked, while the convenience, the cleanliness, the better results, the absence of smells, the ease of controlling the temperatures, and the great saving of labour, would make the change desirable even if it cost more than at present, instead of less. The hot water reservoirs could, if necessary, be heated at night when there is little demand for other current. Imagine a house where the electric current was cheaply available. There would be no fire to light in the morning—the oven could be heated, the kettle boiled, the porridge made, eggs and bacon cooked, the bread toasted—all the heat required obtained by the

turning on of a few switches. No coal, no wood, no ashes to clear away, no smoke, no dust, and no waste heat making the kitchen an oven of itself. When any cooking operation was finished, a switch would be turned off, and heating would cease. In the most recent ovens the temperatures to be obtained are marked on the switch, and so cooking, which depends so much on correct heating, becomes one of the exact sciences. A plentiful supply of hot water would easily be made available for washing or bathing.

When dusting and sweeping had to be done, exhaust sweepers, electrically driven with the exhaust hose discharging on the lee side of the house, would drive dust out into the sterilising sunshine where it would cease to be "dirt," cease to be "matter in the wrong place."

The sewing machines would be driven electrically, as I understand they are now in nearly every home in many American towns—San Francisco for instance. Ironing would be done with an electrically heated iron, and burning with a too-hot iron and waste work with a too-cold iron would be things of the past. With all our 8-hours days and wages boards and arbitration courts, and partly because of them, there seems to be one individual who is getting longer hours, whose money does not go so far as before, and who has no right of appeal to any wages board or arbitration court—I refer to the mother. Help in the housework is getting more and more beyond her reach as its cost rises, the general increased cost of living affects her nearly as the buyer for the family, and, help or no help, the work must be done, starting at daybreak and finishing long after dark. There is no one who would be more relieved and helped by "electrifying" our energy supply than the mother, and there are none who stand more in need of help or are more deserving.

Another result of cheap electrical supply would be the establishment of home industries. The principal reason for gathering hundreds of workers into factories in many industries, is the fact that power is provided more cheaply there, enabling work to be produced at a lower cost than before. But if the power is supplied just as cheaply to run a sewing machine or a loom, or a wood-turning lathe at home, as to run suburban trains and factories, the main reason for congregating sewing machines, looms, or wood-

turning lathes into factories ceases to exist. The cost of carriage of goods is somewhat greater, but where cheap electricity is supplied, it is found that the worker much prefers the independent life at home to the fixed hours of the factory. The cost of the machinery has proved no bar, as makers have shown themselves only too willing to advance them on the time-payment system. Cheap electrical supply would soon give us a sturdy independent class of home workers.

Electrification of trains would, of course, follow with an enormous saving in cost of haulage, in cleaning of carriages and in waste of passengers' clothes.

If such a cheap source of power were available in Brisbane, it would assuredly straightway become the greatest manufacturing city in Australasia. The manufacturer here, with the cheap power, would undersell his rivals elsewhere who used power at about 6 or 10 times the cost; while ore smelting, which is becoming every day more and more electrical, would certainly make its home here.

And to think that all this enormous gain in cleanliness, in convenience, in time, in money, would cost us, as a community, less than nothing—that by making the change we would save money.

This great saving of coal and labour can, of course, only be done by the community, that is, by the Government —no private trading company should or could get the necessary monopoly, probably no one else could raise the necessary capital to effect the change. It would mean buying up several private interests at present supplying some of our wants, probably not more than five companies, but the enormous savings to be made and the gain otherwise would make it a very profitable matter indeed to buy each of these interests at an honest price. There seems a tendency nowadays to confiscate private interests by taxation or by Government competition. Where such interests have been honestly acquired and are honestly serving the public as they are in Brisbane, no other course should be adopted than honestly buying them back. Competition by the Government would virtually mean confiscation. And the scheme is no wild Utopian idea—it requires no new discoveries, no new inventions, scarcely any new laws. In November, 1910, the President of the Society of

Electrical Engineers promulgated such a scheme for England, and calculated that electricity could be supplied at one-eighth penny per unit.

There are other forms of national waste which have not yet received the serious attention of those who look after the welfare of our nation. A few years ago, I heard one of our educational authorities state that nearly two years of a young man's life were practically wasted by the overlapping of the State school, the Grammar School and the Southern Universities. Fortunately that can no longer be said, and the education of our youth is now in the process of being made as nearly continuous as possible. It is to be hoped that before long there will be no overlapping, and that a student will not require to reach first year University standard in certain subjects ere entering the University.

The passing from the State School should qualify for the High School, and passing from the High School should qualify for the University, with no side-tracking of education to coach the student to "pass an exam." That efficient system of inspection, as opposed to examination, which has succeeded so well in our Primary Schools, should succeed quite as well in our Secondary Schools. If, in any instance, it did not, the University would soon let the fact be known.

Possibly the saddest of all our wastes is that direct waste of human life which could so easily, in many cases, be avoided. In the case of adults phthisis and typhoid are largely preventable, if watched by the individual and fairly attacked by the community, while malaria, filaria and other mosquito-borne diseases can easily be eradicated. But of all the life losses, the most inexcusable and criminal is that of infant life. Times without number the appalling statistics have been published, but with only a comparatively slight lowering of the infantile death rate. It seems almost impossible to drive home to those controlling the community, in any land, their criminal responsibility for permitting the wholesale slaughter to go on. Much of the waste of infant life is due to ignorance of the most elementary facts of infant nutrition. I knew of a baby three weeks old, the mother unable to suckle it, being fed with tapioca made with water, and of several other cases almost as bad,

the mothers being fairly well educated otherwise although knowing nothing of babies. I suppose any medical practitioner could supply hundreds of similar instances. Surely there is something wrong with a system of education which teaches a girl who is presumably going to be a mother, nothing whatever about maternal duties and responsibilities. Motherhood is, or ought to be, the supreme crown of nearly every woman's life, and her education ought first of all and before everything else, fit her for that which is her greatest duty, if also her greatest privilege and happiness, and this could easily be done without in the slightest degree sacrificing her general education. There is no question that good mothers are the greatest asset of any nation, and we ought to see to it that the education of our girls fits them for that high position. There is another direction in which even quicker results can be obtained in lowering the infant death rate—that of stopping the milk poisoning. It is universally agreed by sanitarians that the high infant mortality of the summer months is due to bacteria in milk, bacteria to which adults are mostly immune. These bacteria get into the milk after it leaves the cow's udder, in other words, they get there through filthy methods of milking and storing the milk. Milk, when it leaves the udder of a healthy cow, is in a sterile condition. The calf gets sterile milk, the baby gets the filthy milk. It has been pointed out that if the death rate among calves was as high as among babies, every breeder of cows would soon become bankrupt. We kill during the early summer months more than one baby every day in the Brisbane district, through this filthy milk, yet practically no steps are taken to stop the legalised murder. Several municipalities in other countries have demonstrated that this particular waste of human life can be stopped, and they have stopped it, and at a very small cost indeed. One London hospital actually bought a farm, got a healthy herd together, milked the cows with milking machines under perfect sanitary conditions, separated the milk, chilled the separated milk and cream, sent them by rail in chilled storage to London, and then got the pure wholesome cold-stored products for mixing again for each child as prescribed, at a smaller

cost than they had previously been paying for the filthy death-dealing article.

What is the moral condition of a community which, with such absolutely convincing evidence before it as to the possibility of protecting these innocent lives, allows them to be slain by the hundred year after year? Herod had some excuse, if no reason, for his "Massacre of the Innocents," who could not have numbered so very many in the small village of Bethlehem; he thought his throne and life were in danger. We certainly have neither excuse nor reason for killing a far greater number every year in Brisbane.

And now having rather hastily run over a few of the more obvious sources of national waste, let me say that the way out in nearly every instance lies in bringing men who have been properly educated, to deal with the problems to be attacked. For attacking each separate problem, education, along specialised lines, is essential for the best results. For some of the problems, the material solution has already been shown in other lands; the only difficulty is in educating our community to take the necessary action. In the cases of other problems, more knowledge is required, and I trust that not one of the least honourable tasks undertaken by the young graduates of our new University, will be the solution of problems such as these.

I have said nothing of the present wasteful methods of the system of party politics by which we are governed. It has been many times pointed out that no sane business man would ever attempt to conduct his private business along the lines now used for doing the national business. The methods of election, the franchise used, the choosing of the ministry, the giving of the ministry legislative control, the methods in use while legislating—in fact the whole "party" system, requires to be put back into the crucible and remelted. The greater proportion will be found waste material, and a committee of capable business experts, not men who give too much weight to precedent, should take the resultant pure metal in hand, and from it construct a system by which the business of the country could be conducted in a more sane manner than it is at present. Every politician who has written on the matter, has deplored the waste of time and energy which the present

system entails, yet nothing is done. It has been pointed out that a leader who brought about the change, would commit political suicide. Let us pray that a leader will soon arise in the Empire who will value the good of his country above that of his own political life. The current literature of the Old Country, even more than that of Australia, emphasises the fact that the nation is getting quite as tired of the present system as the politicians are. With the public so educated, the hour is here, let us hope that the hour brings the man. My reason for introducing the debatable subject of politics at all, is that most of the larger problems I have mentioned to-night must be dealt with by politicians, and they are severely handicapped in their attempts to obtain national efficiency by the methods which our present system forces them to adopt.

May the time soon come when it will be recognised as the principal duty of our various Governments to so control and direct the States, that the maximum results will be obtained from the efforts of every individual in every trade and profession, and that the national assets of the State will be conserved for our children.

And the way out does not lie in wasteful wars between Labour and Capital, between Individuals and Communism. We must have labour and capital, we must have individual freedom and control by the community, and when we, as a people, are sufficiently educated to recognise that fact and abandon the system of party Government, we will have taken the first and greatest step towards evolving a proper State Control in which waste will be as carefully guarded against, and individuality as jealously fostered as in the keenest of private businesses.

A vote of thanks was proposed by Mr. Richards, and seconded by Mr. Brünnich. An interesting discussion followed in which His Excellency, Mr. Barton and Mr. Brünnich took part, and Mr. Henderson briefly replied.

The following officers were returned unopposed. President, P. L. Weston, B.Sc., B.E.; Vice-President, H. C. Richards, M.Sc.; Hon. Treasurer, J. C. Brünnich, F.I.C.; Hon. Secretary, F. Bennett; Hon. Librarian, T.

Harvey-Johnston, M.A., D.Sc., F.L.S.; Councillors, H. J. Priestley, M.A., E. H. Gurney, J. B. Henderson, F.I.C., J. F. Bailey, J. Shirley, B.Sc.

The President could not be installed as his train could not arrive in time, and the Hon. A. Norton was absent through illness.

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OFFICERS, 1913.

CONTENTS.

A CENSUS OF AUSTRALIAN MALLOPHAGA.

By T. HARVEY JOHNSTON, M.A., D.Sc., F.L.S., and LAUNCELOT HARRISON.

Read before the Royal Society of Queensland, April 24th, 1912.

WITH the exception of a few short papers by Messrs. Le Souef and Bullen, in the Victorian *Naturalist* (see Literature list), no work on *Mallophaga* has been done in Australia. The forms from Australian hosts that we list have been described by various European writers, rarely from material collected from the hosts in their natural state, but more often taken from skins in European museums, or from animals in captivity in the collections of the various Zoological Societies. It is to be expected that records of this nature will require some revision, as some straggling is bound to occur.

The names of bird hosts are in accordance with Mathews' Handlist (1908), which is itself based on Sharpe's Handlist of Birds (1899). The synonym under which the host was originally quoted is in all cases given. Parasites from domesticated and introduced animals are dealt with in a separate paper. We have not included parasites described elsewhere from species, the range of which includes Australia, and the Australian seas: nor those from oceanic birds, except where a definite Australian reference is given. In one or two instances, new names have been used to replace others which were preoccupied.

Mr. Le Souef having kindly placed his collection of *Mallophaga* at our disposal, we are able to establish some synonymy after examination of his types. The making of new records from our own collections is left for a later communication.

It will be seen that Mallophaga have been recorded from but 48 out of nearly 900 bird species listed by Mathews; and from only 7 marsupials.

MALLOPHAGA FROM BIRDS.

DROMÆUS NOVÆHOLLANDIÆ, Lath.

Degeeriella asymmetrica, [Nitzsch], Johnston & Harrison, 1912.

Syns. *Nirmus asymmetricus*, Nitzsch, 1866, xxviii., p. 370 : Nitzsch in Giebel, 1874 p 151, pl. 8, figs. 8-9 ; Piaget, 1877, p. .... ; 1880, p. 205, pl. 17, fig. 3 (Paris Zoo).

Nirmus setosum, Le Souef & Bullen, 1902, xviii.' p. 157, figs. 5-6 (*nec. N. setosus*, Giebel, 1876).

We have examined the type of *N. setosum*, Le Souef and Bullen, and find it to be identical with Nitzsch's species as described and figured in both Giebel and Piaget. Le Souef figures the male as possessing continuous bands on the posterior segments of the abdomen. This appearance is due to the strong ventral markings showing through in the cleared and mounted specimens. We have examples from the same host from Queensland, New South Wales, and Victoria.

Lipeurus pallidus, Giebel, 1866 (*nec.* Piaget, 1880).

Recorded from this host. Stated by Giebel (1874, p. 219) to agree so completely with *L. heterographus* from the domestic fowl, that he considers th two species identical, and the emu merely an accidental host.

CATHETURUS LATHAMI, Lath.

Goniocotes fissus, Rudow.

Rudow, 1869, p. 23 (New Holland) ; 1870, xxxv., p. 477 ; Giebel, 1874, p. 187 ; Piaget, 1880, p. 231 ; Taschenberg, 1882, p. 84, pl. 2, figs. 7-7A (Hamburg Museum).

Goniocotes macrocephalus, Taschb.

Taschenberg, 1882, p. 87, pl. 2, fig. 11. (Hamburg Museum).

Lipeurus crassus, Rudow.

Rudow, 1870, p. 127 ; Giebel, 1874, p. 217 ; Piaget, 1880, p 259 ; Taschenberg, 1882, p. 174.

Lipeurus ischnocephalus, Taschenberg.

Taschenberg, 1882, p. 173, pl. 6, fig. 8.

SYNŒCUS AUSTRALIS, Temm.

Goniodes elongatus, Piaget.

Mr. A. S. Le Souef has collected specimens, which we identify as belonging to this species, from the above host in Victoria.

Goniodes retractus, Le Souef, 1902, xix., p. 90.

The male of this species is unknown, and it is possible that the species may have to be referred to the genus *Goniocotes* on its discovery. Locality, Victoria.

EXCALFACTORIA LINEATA, Scop.

Oxylipeurus acuminatus, [Piaget], Mjoberg.

Mjoberg, 1910, p. 92.

Syn. *Lipeurus acuminatus*. Piaget.

Piaget, 1885, p. 70, pl. 7, fig. 6. Host quoted as *E. australis*. Leyden Museum.

Goniodes elongatus, Piaget.

Piaget, 1885, p. 53, pl. 5, fig. 10 ; 1880, p. 281, pl. 23, fig. 5.

Syn. *Goniodes longus*, Le Souef, 1902, xix, p. 90.

Taschenberg (1882, p. 71), believes this form to be identical with *Goniocotes asterocephalus*, Nitzsch, but Piaget (1885, p. 53) upholds the validity of the species Host quoted as *E. australis*, Leyden Museum.

We have examined Le Souef's type of *G. longus*, and find it identical with *G. elongatus*, Piaget. Host quoted as *E. chinensis*, Victoria.

MEGALOPREPIA MAGNIFICA, Temm.

Lipeurus columbae, [Linn].

Syn. *Lipeurus baculus*, Nitzsch, 1818.

This common parasite of pigeons is given as occurring on *Carpophaga magnifica* by Taschenberg (1882, p. 125). No locality is stated.

MACROPYGIA PHASIANELLA, Temm.

Colpocephalum albidum, Giebel.

Recorded by Piaget (1880, p. 534, pl. 44. fig. 5), from *Columba phasianella*.

PHAPS CHALCOPTERA, Lath.

Goniocotes flavus, [Rudow], Giebel, 1874.

Syn. *Goniodes favus*, Rudow, 1870, p. 486.

Goniocotes flavus, Giebel, 1874, p. 188; Piaget, 1880, p. 236; Taschenberg, 1882, p. 101, pl. 3, figs. 5-5A.

Lipeurus angustus, Rudow.

Rudow, 1869, p. 34; 1870, p. 137; Giebel, 1874, p. 216; Piaget, 188 , p. 306; Taschenberg, 1882, p. 123. From Tasmania. Taschenberg (1882, p. 123) considers that the species is probably identical with *L. baculus* (=*L. columbae*).

Lipeurus columbae, [Linn.], Neumann.

Syn. *L. baculus*, Nitzsch.

Recorded from the above host by Taschenberg (1882, p. 123), as *L. baculus*.

Colpocephalum albidum, Giebel.

Giebel, 1874, p. 268.

LEUCOSARCIA PICATA, Lath.

Lipeurus columbae, [Linn.], Neumann.

Recorded from the above host by Taschenberg (1882, p. 124). Host quoted as *L. plicata* and the parasite as *Lip. baculus*.

RALLINA TRICOLOR, Gray.

Rallicola bisetosa, [Piaget], Johnston & Harrison, 1912.

Syn. *Oncophorus bisetosus*, Piaget, 1880, p. 218. Leyden Museum.

MICROTRIBONYX VENTRALIS, Gould.

Goniodes cornutus, Rudow

Rudow, 1869, p 26; 1870, p 485; Giebel, 1874, p. 205; Piaget, 1880, p. 284.

PORPHYRIO MELANONOTUS, Temm.

Rallicola fallax, [Piaget], Johnston & Harrison, 1912.

Syn. *Oncophorus fallax*, Piaget, 1880, p. 220, pl. 18, fig. 6. Eastern Australia, Leyden Museum.

DAPTION CAPENSIS, Linn.

Ancistrona procellariae, Westwood.

Syn. *A. gigas*, Piaget.

Recorded from the above host by one of us (L H., 1911) from Narrabeen, New South Wales.

STERNA BERGII, Licht.

Colpocephalum crassipes, Piaget.

Recorded by Piaget (1880, p. 566) from a specimen of *S. poliocerca* in Leyden Museum. As this is Gould's species from S. E. Australia, now merged in *S. bergii*, we have included the reference, although no direct Australian locality is given.

HYDRALECTOR GALLINACEUS, Temm.

Rallicola sulcata, [Piaget], Johnston & Harrison, 1912.

Syn. *Oncophorus sulcatus*, Piaget, 1880, p. 218. pl. 18, fig. 5. Rotterdam Zoo.

ANTIGONE AUSTRALASIANA, Gould.

Philopterus integer, Nitzsch.

Syn. *Docophorus integer*, Nitzsch, 1886, p. 360; Giebel, 1874, p. 95: Piaget, 1880, p. 99.

Docophorus novæhollandiæ, Giebel, 1866, xxviii., p. 360, 1874, p. 96.

Giebel described the form from the above host (quoted as *Grus novæhollandiæ*) as a distinct species. Piaget does not uphold the distinction.

Lipeurus giganteus, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 156, fig. 1.

Lipeurus gruis, [Linn.] Johnston & Harrison, 1912.

Syn. *L. ebræus*, Nitzsch, 1818.

L. hebræus, Nitzsch, 1866, p. 382; Giebel, 1874, p. 226.

Taschenberg (1882, p. 133) records the occurrence of *L. hebræus* on *Grus novæhollandiæ*.

We have examined specimens of the last two species from the same host from Queensland, Victoria, and N.S. Wales.

IBIS MOLUCCA, Cuv.

Lipeurus ibis, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 156, fig. 2. Host quoted as *Threskiornis stictipennis*.

PLATIBIS FLAVIPES, Gould.

Ornithobius fuscus, Le Souef.

Le Souef (1902, xix., p. 91) states that he has met with *O. fuscus* on the Australian spoonbill. Possibly it has only straggled from a swan.

XENORHYNCHUS ASIATICUS, Lath.

Philopterus horridus, Giebel.

Syn. *Docophorus horridus*, Giebel, 1876, p. 249; Piaget, 1880, p. 97.

Host quoted as *Ciconia australis.*

NOTOPHOYX NOVÆ-HOLLANDIÆ, Lath.

Lipeurus unguiculatus, Piaget.

Piaget, 1888, xxxi., p. 247, Pl. 10, fig. 2.

Host quoted as *Herodias novæhollandiæ.*

CHENOPSIS ATRATA, Lath.

Lipeurus anatis megaceros, Johnston & Harrison, 1912.

Syn. *Lipeurus squalidus*, var. *antennatus*, Piaget, 1880, p. 346. *L. squalidus*, Nitzsch, is a synonym of *L. anatis*, Fabricius. The name *antennatus* is preoccupied by *L. antennatus*, Giebel (1874, p. 213). We therefore propose to substitute the sub-specific name *megaceros* as above. Host quoted as *Cygnus atratus*, Rotterdam Zoo.

Ornithobius fuscus, Le Souef.

Le Souef, 1902, xix., p. 91. Victoria.

Trinoton niger, Le Souef.

Le Souef, 1902, xix.; p. 91. Victoria.

Colpocephalum castaneum, Piaget.

Piaget, 1885, p. 153, Pl. 16, fig. 7. Host quoted as *Cygnus atratus*, Rotterdam Zco.

CEREOPSIS NOVÆ-HOLLANDIÆ, Lath.

Lipeurus australis, Rudow.

Rudow, 1869, p. 38; 1870, p. 130; Giebel, 1874, p. 239; Piaget, 1880, p. 351; Taschenberg, 1882, p. 164.

Taschenberg notes that this species is closely related to *L. jejunus* Nitzsch (=*L. crassicornis*, Olfers), his material coming from the Hamburg Museum.

NETTIUM GIBBERIFRONS, S. Müll.

Lipeurus anatis major, Piaget.

Syn. *Lipeurus squalidus*, var. *major*, Piaget, 1880 p. 346. Host quoted as *Anas gibberiformis.*

PHALACROCORAX SULCIROSTRIS, Brandt.

Lipeurus setosus, Piaget.

Piaget, 1880, p. 335, Pl. 27, fig. 4. Host quoted as *Phalacrocorax* (*Graculus*) *sulcirostris*, Leyden Museum.

Menopon subrotundum, Piaget.

Piaget, 1880, p. 453, Pl. 35, fig. 2. Host quoted as *Gracula sulcirostris*, Rotterdam Zoo.

SULA SERRATOR, Gray.

Philopterus breviantennatus, [Piaget] J. &. H., 1912.

Syn. *Docophorus breviantennatus*, Piaget, 1880, p. 108, Pl. 9, fig. 9. Host quoted as *Sula australis*; Leyden Museum.

Pectinopygus gyricornis (Denny) J. &. H., 1912.

Syn. *Lipeurus gyricornis*, Denny.

Piaget, (1880 p. 337, Pl. 27, fig. 8) records this species—originally described by Denny (1842, p. 167) from a tern, *Sterna hirundo*—from *Sula australis*, Leyden Museum. This species has the typical form of Lipeures from *Sula*.

Menopon albescens, Piaget.

Piaget, 1880, p. 491, Pl. 41, fig. 4. Host quoted as *Sula australis*.

MICROGLOSSUS ATERRIMUS, Gmel.

Colpocephalum temporale, Piaget.

Piaget, 1888, p. 252, Pl. 10, fig. 6. Host quoted as *Psittacus aterrimus*, Rotterdam Zoo.

Degeeriella paraboliceps, [Piaget]. J. &. H., 1912.

Syn. *Nirmus paraboliceps*, Piaget, 1880, p. 135, Pl. 11, fig. 5. Host and locality as above.

CALYPTORHYNCHUS VIRIDIS, Vieill.

Lipeurus circumfasciatus, Piaget.

Piaget, 1880, p. 301, Pl. 24, fig. 6. Taschenberg (1882, p. 118, Pl. 3, fig. 13) records this species from the above host under the name of *C. leachi*, no locality being given.

CACATUA GALERITA, Lath.

Lipeurus albus, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 157, fig. 4. Victoria.

CACATUA ROSEICAPILLA. Vieill.

Degeeriella eos. [Rudow.] J. & H., 1912.

Syns. *Nirmus eos*, Rudow, 1870, xxxv., p. 471 ; Giebel, 1874, p. 181 ; Piaget, 1880, p. 137.

Nirmus tenuis, Rudow, 1870,, xxxv., p. 471 (*nec*, Nitzsch in Burmeister, 1832, p. 429).

Giebel has quoted this host under two different names,—as *Plictolophus roseocapillus* in his Index (1874, p. x.), and as *Cacatua eos* in the text (1874, p. 181) ; Gurlt (1878), in preparing his list, has copied Giebel's names, but has quoted them as referring to two distinct hosts, *Psittacus eos* and *Psittacus roseocapillus* (*fide* Piaget, 1880, p. xvii.)

CALOPSITTACUS NOVÆ-HOLLANDIÆ, Gmel.

Goniocotes fasciatus, Piaget.

Piaget, 1880, p. 236, Pl. 19, fig. 11. Host quoted as *Nymphicus novæ-hollandiæ*, Leyden Museum and Rotterdam Zoo. It is questionable whether this species should be included in its present genus.

POLYTELIS BARRABANDI, Swains.

Philopterus angustoclypeatus, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus angustoclypeatus*, Piaget, 1880, p. 34, pl. 2. fig. 3. Host recorded as *Platycercus barrabandi*.

Philopterus forficula, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus forficula*, Piaget, 1871, p..... ; 1880, p. 32, pl. 2, fig. 1. Host as above.

Colpocephalum trimaculatum, Piaget.

Piaget, 1880, p. 525, pl. 43, fig. 8. Host as above ; Rotterdam Zoo.

POLYTELIS MELANURA, Vig.

Lipeurus circumfasciatus, Piaget.

Piaget, 1880, p. 301, pl. 24, fig. 6 ; Taschenberg, 1882, p. 118, pl. 3, fig. 13. Host given as *Platycercus melanurus*, Leyden Museum.

APROSMICTUS CYANOPYGIUS, Vieill.

Philopterus forficula, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus forficula*, Piaget, 1871, p. .... ; 1880, p. 32, pl. 2 fig. 1. Host given as *Platycercus scapulatus*.

PLATYCERCUS ELEGANS, Gmel.

Philopterus forficula, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus forficula*, Piaget, 1871, p. .... ; 1880, p. 32, pl. 2. fig. 1. Host given as *P. pennantii*.

PLATYCERCUS PALLIDICEPS, Vig.

Colpocephalum trimaculatum, Piaget.

Piaget, 1880, p. 525, pl. 43, fig. 8. Host quoted as *P. palliceps*, Rotterdam Zoo.

PLATYCERCUS EXIMIUS, Shaw.

Philopterus forficula, [Piaget], Johnston & Harrison, 1912.

Syn. *Docophorus forficula*, Piaget, 1871, p. .... ; 1880, p. 32, pl. 2, fig. 1.

Menopon psittacus, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 158, fig. 8.

BARNARDIUS ZONARIUS, Shaw.

Philopterus forficula, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus forficula*, Piaget, 1871, p. ....; 1880, p. 32, pl. 2. fig. 1. Host quoted as *Platycercus baueri*, (p. 33) and *P. zonarius* (*baueri*) (p. 684).

DACELO GIGAS, Bodd.

Philopterus delphax, [Nitzsch] Johnston & Harrison, 1912.

Syn. *Docophorus delphax*, Nitzsch, 1866, p. 360 ; Nitzsch in Giebel, 1874, p. 92. Host quoted as *Dacelo gigantea*, Halle Museum. Piaget, 1880, p. 75.

Degeeriella bracteata, [Nitzsch] Johnston & Harrison, 1912.

Syn. *Nirmus bracteatus*, Nitzsch, 1866, p. 369; Giebel, 1874, p. 145; Piaget, 1880, p. 163. Host as above.

Degeeriella goniocotes, [Piaget] Johnston & Harrison, 1912.

Syn. *Nirmus goniocotes*, Piaget, 1885, p. 33, pl. 4, fig. 3. Host given as *Dacelo gigas* from Madagascar (Leyden Museum). As this bird is confined to Australia, either the locality or the host is incorrectly stated.

Menopon infumatum, Piaget.

Piaget, 1885, p. 106, pl. 11, fig. 7. Reference to same host and locality as last species.

CACOMANTIS RUFULUS, Vieill.

Philopterus laticlypeatus, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus laticlypeatus*, Piaget, 1871, p.....; 1880, p. 37, pl. 2. fig. 9. Host given as *Cuculus flabelliformis* from New Holland, Leyden Museum.

SCYTHROPS NOVÆHOLLANDIÆ, Lath.

Philopterus obcordatus, [Piaget] Johnston & Harrison, 1912.

Syn. *Docophorus obcordatus*, Piaget, 1871, p. ....; 1880, p. 38, pl. 2, fig. 10. Leyden Museum.

Degeeriella lipeuriformis, [Rudow] Johnston & Harrison, 1912.

Syn. *Nirmus lipeuriformis*, Rudow, 1870, p. 470; *Nirmus chelurus*, Nitzsch in Giebel, 1874, p. 150; Piaget, 1880, p. 138. Dry skin; Paris. Giebel, (1874, p. 151) establishes the identity of Rudow's and Nitzsch's species, but wrongly retains Nitzsch's name.

Menopon platygaster, Giebel.

Giebel, 1874, p. 290; Piaget, 1880, p. 420, pl. 32, fig. 5. Leyden Museum.

MENURA SUPERBA, Davies.

Philopterus paraboliceps, [Piaget] J. & H., 1912.

Syn. *Docophorus paraboliceps*, Piaget, 1888, p. 224, pl. 8, fig. 2. Host quoted as *Menura lyra*.

Degeeriella submarginalis, [Burmeister] J. & H., 1912,

Syn. *Nirmus submarginalis*, Burmeister, 1832. p. 431; *N. submarginellus*, Nitzsch, 1866, p. 368; Giebel, 1874, p. 148; Piaget, 1880, p. 155; 1885, p. 22, pl. 3, fig. 2 (Halle Museum); *N. menurae-lyrae*, Coinde, 1859, p. 424; *N. menura*, Le Souef & Bullen, 1902, p. 157.

Kellogg (1908, p. 27) gives *Menura superba* as a host of *Nirmus* (i.e. *Degeeriella*) *marginalis*, Nitzsch. We cannot find any reference justifying this, hence we have concluded that it is an error.

MENURA VICTORIÆ, Gould.

Lipeurus menura, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 157, fig. 3.

Menopon menura, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 158, fig. 9.

Degeeriella submarginalis, [Burmeister].

Syn. *Nirmus menura*, Le Souef and Bullen, 1902, xviii., p. 157. For full synonymy, see under *Menura superba*. We have examined Le Souef and Bullen's type of *N. menura*, and find it identical with the above species. These authors quote the host as *Menura superba*, but Mr. Le Souef informs us that the birds were the now separated Victorian form *M. victoriæ*.

GYMNORHINA TIBICEN, Lath.

Degeeriella bimiaculata, [Piaget] Johnston & Harrison, 1912.

Syn. *Nirmus bimaculatus*, Piaget, 1885, p. 148, pl. 16, fig. 1. Host given as *Baryta tibicen*, Rotterdam Zoo.

GYMNORHINA LEUCONOTA, Gray.

Degeeriella semiannulata, [Piaget] Johnston & Harrison, 1912.

Syn. *Nirmus semiannulatus*, Piaget, 1883, p. 156; 1885, p. 24, pl. 3, fig. 11. Host quoted as *Baryta leuconota*.

Piaget (1880, p. 140) records *Nirmus varius* (*i.e. Degeeriella varia*) Nitzsch, from the above host. This is a common parasite of European crows, and prob-

ably straggled from one of these on to the *Gymnorhina*, which was very probably a captive in the Rotterdam Zoo, where much of Piaget's material was collected.

PARDALOTUS PUNCTATUS, Shaw.

Menopon, sp.

Giebel (1874, p. 286) mentions that Nitzsch had a damaged individual of a species of *Menopon* from the above host, which was not in sufficiently good condition to justify description. Nitzsch considered it to be closely allied to his own *M. minutum*.

GLYCIPHILA FASCIATA, Gould.

Goniocotes candidus var. *pellucidus*, Piaget.

Piaget, 1885, p. 40, pl. 4, fig. 10. Leyden Museum. This is possibly a straggler, as it is extremely unlikely that *Goniocotes* should occur on the *Meliphagidæ*, and particularly on such a small honey-eater as *G. fasciata*.

PTILONORHYNCHUS VIOLACEUS, Vieill.

Philopterus grandiceps, [Giebel] Johnston and Harrison, 1912.

Syn. *Docophorus grandiceps*, Giebel, 1874, p. 85; Piaget, 1880, p. 53, Host quoted as *P. holosericeus*.

Degeeriella pontoni, Johnston & Harrison, 1912.

Syn. *Nirmus nitzschi*, Ponton, 1871 (nec. Giebel, 1866, p. 364; 1874, p. 125). This species is referred to by Gurlt (1878). Piaget merely mentions the name. We have not been able to consult Ponton's original description. As the specific name *nitzschi* was preoccupied by Giebel in 1866, we have substituted for it *pontoni*, in compliment to the author of the species.

Giebel (1874, p. 133) gives a brief description of *Nirmus* (=*Degeeriella*) sp. from the above host, collected from a dry skin, but not in sufficiently good condition to allow description.

SERICULUS CHRYSOCEPHALUS, Lewin.

Degeeriella hectica, [Nitzsch] Johnston & Harrison, 1912.

Syn. *Nirmus hecticus*, Nitzsch, 1866, p. 366; Giebel, 1874, p. 136; Piaget, 1880, p. 161. Host quoted as *Sericulus regens*.

STREPERA GRACULINA, White.

Colpocephalum vinculum, Le Souef & Bullen.

Le Souef & Bullen, 1902, xviii., p. 158, fig. 10.

MALLOPHAGA FROM MARSUPIALS.

MACROPUS GIGANTEUS, Zimm.

Heterodoxus longitarsus, [Piaget] Johnston & Harrison, 1912.

Syn. *Menopon longitarsus*, Piaget, 1880, p. 504, pl. 41, fig. 7. Rotterdam Zoo. Host quoted as *Halmaturus giganteus*.

MACROPUS RUFUS, Desm.

Boopia grandis, Piaget.

Piaget, 1885, p. 154, pl. 16, fig. 8.

MACROPUS DORSALIS, Gray.

Boopia minuta, Le Souef.

Le Souef, 1902, xix., p. 51, fig. 8.

MACROPUS UALBATUS, Less & Garn.

Boopia notafusca, Le Souef.

Le Souef, 1902, xix., p. 50, fig. 1.

"Kangaroos and Wallabies."

Heterodoxus longitarsus, [Piaget] Johnston & Harrison, 1912.

Syn. *Menopon longitarsus*, Piaget, 1880, p. 504 pl. 41, fig. 7. *Heterodoxu macropus*, Le Souef & Bullen, 1902, xviii., p. 159, fig. 11 ; Froggatt, 1907, p. 391. We have examined the types of *Heterodoxus macropus*, Le Souef and Bullen, and find the species to be identical with that described by Piaget as *Menopon longitarsus*. No hosts are indicated specifically by the former authors. We will deal more fully with the host distribution of this parasite in a forthcoming paper on Mallophaga from Marsupials.

Latumcephalum macropus, Le Souef.

Le Souef, 1902, xix., p. 51, fig. 4.

PETROGALE PENICILLATA, Gray.

Trichodectes penicillatus, Piaget.

Piaget, 1880, p. 506, pl. 32, fig. 10, Rotterdam Zoo. Taschenberg (1882, p. 214) states that this

species is identical with *Tr. crassipes*, Rudow (1886, p. 111, pl. 7, fig. 1) from the Angora goat. Raillet (1895, p. 837) and Neumann (1905, p. 65) refer to the species, suggesting that in one of the above cases the host is wrongly indicated. Material collected by ourselves from the above host does not include any *Trichodectes*, nor have we found a member of this genus on any of a large number of marsupials examined.

AEPYPRYMNUS RUFESCENS, Gray.

Boopia bettongia, Le Souef.

Le Souef, 1902, xix., p. 50, fig. 2. Host quoted as *Bettongia rufescens*.

PHASCOLOMYS URSINUS, Shaw.

Boopia tarsata, Piaget.

Piaget, 1880, p. 599, pl. 50, fig. 1. Host quoted as *Phascolomys fossr*.

Colpocephalum truncatum, Piaget.

Piaget, 1880, p. 540, pl. 45, fig. 2. Piaget (1880, p. 542) records finding this species, which is a parasite of *Grus communis*, on a wombat. This is evidently a case of straggling.

LITERATURE LIST.

1832 Burmeister—Handb. d. Entomol, 1832.

1859 Coinde—Bull. Soc. imp. Nat., Moscou, xxxii., 1859.

1842 Denny—Monogr. Anoplurorum Britanniae, London, 1842.

1907 Froggatt—Australian Insects, Sydney, 1907.

1866 Giebel—Z.f. ges. Naturwiss., xxviii.

1874 Giebel—" Insecta Epizoa, etc." Liepzic, 1874.

1876 Giebel—Z. f. ges. Naturwiss.

1878 Gurlt—Arch. f Naturgesch., xliv.

1911—Harrison—Proc. Linn. Soc., N.S.W., Notes and Exhibits, pt. 3, 1911.

1911 Johnston & Harrison—" Notes on some Mallophagan Generic Names," P.L.S., N.S.W. 1911.

1912 Johnston & Harrison—"A Census of Australian Mallophaga." Proc. Roy. Soc. Queensland, 1912. (The present paper.)

1908—Kellogg—"Mallophaga," in Wytsmann's "Genera Insectorum" Fasc. 66.

1902—Le Souef—Victorian Naturalist, xix., p. 50.

1902 Le Souef & Bullen—Vict. Nat., xviii., p. 155.

1902 Le Souef & Bullen—Vict. Nat, xviii., p. 159.

1908 Matthews—"Handlist of the Birds of Australia." "Emu" vii., pt. 3, 1908, Supplement.

1910 Mjoberg—Arkiv. f. Zoologi. vi., No. 13.

1905 Neumann, "Parasites et Maladies parasitaires des Oiseaux domestiques," Paris, 1909.

1818 Nitzsch—in Germar's Magazin d. Entom., iii, 1818, pp. 261, sqq.

1866 Nitzsch—Zeitschr f. ges. Naturwiss, xxviii.

1874 Nitzsch—(in Giebel) "Insecta Epizoa," 1874.

1871 Piaget—Tijd. v. Ent., xiv.

1877 Piaget—Tijd. v. Ent., xx.

1880 Piaget—"Les Pediculines, Essai Monographique.' Leiden, 1880.

1885 Piaget—"Les Pediculines, Essai Monographique," Supplement, Leiden, 1885.

1888 Piaget—Tijd. v. Ent., xxxi.

1871 Ponton—American Monthly Microscopical Journal, vi.

1895 Raillet—Traite d. Zool. Agric. Medic.

1869 Rudow—Beitrage, etc. Inaug. Dissert. Halle.

1870 Rudow—Zeitschr. f. ges. Naturwiss, xxxv and xxxvi.

1899 Sharpe—"A Handlist of the Genera and Species of Birds," London, 1899, sqq.

1882 Taschenberg—"Die Mallophagen, etc," Nova. Acta. Halle, xliv., 1, 1882.

A LIST OF MALLOPHAGA FOUND ON INTRODUCED AND DOMESTICATED ANIMALS IN AUSTRALIA.

By T. HARVEY JOHNSTON, M.A., D.Sc., and LAUNCELOT HARRISON.

Read before the Royal Society of Queensland, April 24th, 1912.

THE present communication contains a list of the Mallophaga previously recorded as occurring on introduced animals in Australia, as well as several whose presence is now noted in literature for the first time, though some of them are common, well-known forms. We have recently published (J. & H., 1912, *a*,) a census of the species recorded from the native Australian fauna.

The application of the law of priority has necessitated the alteration of some well-known names.

BIRDS.

COMMON FOWL (*Gallus domesticus*).

1. *Lipeurus caponis* (Linn). Syn. *L. variabilis*, Nitzsch. —Common. N.S.W., Victoria,* Q'land, W. Austr.
2. *Lipeurus heterographus*, Nitzsch.—Vict., Sydney (N.S.W.)
3. *Goniodes dissimilis*, Nitzsch —Vict., N.S.W.
4. *Goniocotes gigas*, Tasch.—N.S.W., Q'land. The occurrence of this parasite (quoted as *Gc. abdominalis*) on fowls in N.S.W., has already been recorded by Bradshaw (1909, p. 51). It is fairly common.
5. *Goniocotes hologaster*, Nitzsch.—Uncommon. Melbourne (Victoria).

*We are indebted to Mr. A. S. Le Souef for most of the Victorian material referred to in this paper.

This species was referred to by DeGeer as *Ricinus gallinæ*, which name therefore appears to have priority. Linnæus described a *Pediculus gallinæ* (= *Menopon gallinæ*), but soon afterwards DeGeer divided up the Linnæan genus into *Pediculus* (including the blood-sucking species), and *Ricinus* (including those which feed on epidermal structures). Thus *P. gallinæ* L. should have become *R. gallinæ* (L.), in which case *R. gallinæ* DeGeer would be invalid, as it refers to a different species. DeGeer's work is not available to us, so that we do not know whether that author believed that he was referring to Linnæus' species, or whether he took no cognisance of *P. gallinæ* L. and erected a new species, *R. gallinæ*. We are thus unable to state whether the parasite should be termed *Gc. gallinæ* (Geer), or *Gc. hologaster* (N.), though it seems to us that Nitzsch's name is the more correct.

7. *Menopon gallinæ* (L.)—Syns. *M. trigonocephalum* (Olfers); *M. pallidum*, Nitzsch. A common parasite. N.S.W., Victoria, Queensland, West Australia.

8. *Menopon stramineum*, N.—Syn. *M. biseriatum*, Piaget. Common—N.S.W., Victoria, Q'land.

TURKEY (*Meleagris gallopavo*).

1. *Lipeurus meleagridis* (L.)—Syn. *L. polytrapezius*. N. Sydney (N.S.W.)
2. *Goniodes stylifer*, N. N.S.W., Victoria, Q'land.
3. *Menopon stramineum*, N. N.S.W., Victoria, Q'land.

GUINEA FOWL. (*Numida meleagris*).

1. *Lipeurus caponis* (L.)—Sydney (N.S.W.)
2. *Goniocotes rectangulus* (Nitzsch), Burm.—Sydney. This species is usually quoted as *Gc. rectangulatus* N., but the latter name is a synonym.

PHEASANT (*Phasianus colchicus*).

1. *Lipeurus caponis* (L.) Victoria.
2. *Goniodes colchici*, Denny.—Syn *G. colchicus*, Giebel. Victoria.

PEACOCK (*Pavo cristatus*).

1. *Goniodes pavonis* (L.)—Syn. *G. falcicornis*, Nitzsch. Melbourne, Sydney.

SILVER PHEASANT. (*Gennæus nycthemerus.*)

1. *Menopon fulvomaculatum*, Denny.—Syn. *M. productum*, Piaget. Victoria.

PIGEON (*Columba livia dom.*)

1. *Lipeurus columbæ* (L.)—Syn. *L. baculus*, N. Sydney, Melbourne, Brisbane.
2. *Goniodes* (*Coloceras*) *damicornis*, Nitzsch. Sydney.
3. *Goniodes* (*Coloceras*), *piageti*—nom. nov.—Syn. *Gd. minor*, Piaget (1880, p. 256), nec. *Gd. dispar.* var. *minor*, Piaget (1880, p. 248)*.
4. *Goniocotes bidentatus* (Scopoli).—Syn. *Gc. compar*, Nitzsch. Sydney.
5. *Menopon giganteum*, Denny.—Syn. *M. latum*, Piaget. Sydney.
6. *Colpocephalum turbinatum*, Denny.—Syn. *C. longicaudum*, Nitzsch (1866). Sydney.

INDIAN DOVE (*Turtur suratensis*). A common bird in some Australian cities.

1. *Goniocotes chinensis*, Kellogg & Chapman. Sydney. Previously recorded only from *Turtur chinensis*, from Hawaii.

GOOSE (*Anser domesticus*).

1. *Lipeurus crassicornis* (Olfers).—Syn. *L. jejunus*, Nitzsch. Victoria ; Sydney, Richmond (N.S.W.)

DUCK (*Anas domestica*).

1. *Lipeurus anatis* (Fabr.)—Syn L. *squalidus*, N. Sydney, Melbourne.
2. *Menopon obscurum*, Piaget. Sydney.

MUSCOVY DUCK.

1. *Lipeurus crassicornis* (Olfers). Sydney.

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*According to Article 11, of the International Code of Zoological Nomenclature, "specific and sub-specific names are subject to the same rules . . . . . . and frcm a nomenclatural standpoint, they are co-ordinate - that is, they are of the same value." Hence our substitution of a new specific name for Piaget's species.

SWAN (*Cygnus*, dom.)

1. *Lipeurus crassicornis* (Olfers). Victoria.
2. *Ornithobius fuscus*, Le Souef (1902, p. 91)—Melbourne Zoological Gardens.
3. *Ornithobius cygni* (L.) Victoria, Sydney.

STARLING (*Sturnus vulgaris*).

1. *Philopterus leontodon*, Nitzsch. Sydney.
2. *Degeeriella nebulosa* (Burmeister). Sydney.
3. *Menopon spinosum*, Piaget. Sydney.

SKYLARK (*Alauda arvensis*).

1. *Menopon parviceps*, Piaget. Richmond,* (N.S.W.)

OSTRICH (*Struthio camelus*).

1. *Lipeurus quadrimaculatus*, Piaget. Richmond (N.S.W.). (In collection of Entomological Branch, Dept. of Agriculture, Sydney).

MAMMALS.

ASS (*Equus asinus*).

1. *Trichodectes pilosus*, Giebel (*nec.* Piaget). Victoria.

HORSE (*Equus caballus*).

1. *Trichodectes pilosus*, Giebel. Victoria. Lea (1908, p. 105), refers to this species, but does not state whether it occurs in Tasmania. Linnæus (Syst. Nat. II., 1018), described *Pediculus equi* from the horse. In 1842, Denny (1842, p. 191), gave an account of a parasite which he regarded as belonging to Linnæus' form, as *Trichodectes equi*. In 1874, Giebel (1874, p. 59), described *Tr. pilosus*, ostensibly renaming *Tr. equi*, Denny and *Pediculus equi*, Linn. Piaget (1880, p. 397), in 1880, separated Denny's *Tr. equi* from Linnæus' form, redescribing the former as *Tr. parumpilosus*, while on p. 395, he described what he believed to be *Tr. pilosus*, Giebel, giving as a synonym *Pediculus equi*, Linn. A little later, Taschenberg (1882, p. 214), stated that Piaget was correct in identifying *Tr. equi*, Denny with *Tr. parumpilosus*, and,

*We are indebted to Mr. C. T. Musson, of the Hawkesbury Agricultural College, Richmond, N.S.W., for specimens from this locality.

moreover, after having examined Giebel's specimens, was convinced that *Tr. pilosus*, Giebel, was also synonymous with *Tr. parumpilosus*, Piaget. He went on to state that the two species from horses should be quoted as *Tr. pilosus*, Piaget, and *Tr. parumpilosus*, Piaget. Taschenberg does not appear to have recognized that *pilosus* was already preoccupied when Piaget adopted it. Railliet (1895, p. 835) quoted *Tr. pilosus*, Piaget, *nec.* Giebel, under the name *Tr. vestitus*.

The synonymy of the two species is thus :—

(*a*) *Pediculus equi*, Linn.	(*b*) *Trichodectes equi*, Denny, *nec.* L.
Tr. pilosus, Piaget, *nec.* Giebel.	*Tr. pilosus*, Giebel, *nec.* Piag.
Tr. vestitus, Raill.	*Tr. parumpilosus*. Piaget,

From the foregoing it will be seen that Giebel, without any justification, renamed Denny's and Linnæus' species, believing both to be identical. It has since been shown that his description really referred to Denny's form, and not to *Pedic equi*, Linn. His name thus accidentally becomes the valid one for *Tr. equi*, Denny, *nec.* Linn., with *Tr. parumpilosus*, Piaget as synonym, while the Linnæan species must stand for the less common parasite, *Tr. equi* (L.), with *Tr. pilosus*, Piaget, *nec.* Giebel and *Tr. vestitus*, Raill, as synonyms. It might be stated here that Piaget's names are those generally used, but from the above discussion it will be seen that this should not be the case. Osborn (1891, p. 45-7) followed Piaget's nomenclature.

Ox (*Bos taurus*).

1. *Trichodectes bovis* (L.)—Syn. *Tr. scalaris*, Nitzsch. N.S.W., Johnston, 1911, p. 217. Queensland. We have restored Linnæus' specific name.

Sheep (*Ovis aries*).

1. *Trichodectes ovis* (L.), Raill.—Syn. *Tr. sphaerocephalus*, Nitzsch. Victoria, N.S. Wales. Lea (1908, p. 105), has recorded the presence of this species under Nitzsch's name in Tasmania.

GOAT (*Capra hircus*).

1. *Trichodectes climax*. Nitzsch, Victoria, Nitzsch's name was published in 1818, but no description appeared (as far as we are aware) until Gervais published one in 1844.

CAT (*Felis domestica*).

1. *T. ichodectes subrostratus*, Nitzsch. Victoria.

GUINEA PIG (*Cavia cobaia*).

1. *Gyropus ovalis*. Sydney.
2. *Gliricola porcelli* (Schrank)—Syns. *Gyropus gracilis*, Nitzsch; *Gliricola gracilis*, Mjoberg (1910, p. 18). We have reinstated Schrank's name on account of its priority, even though it is very inappropriate.*

LITERATURE.

1909. Bradshaw, Farmers' Bull. 15, Dept. Agr., N.S.W.
1842. Denny, Monogr. Anoplur. Brit., London.
1907. Froggatt, Australian Insects, Sydney.
1874. Giebel, Insecta Epizoa, Leipzig.
1911. Johnston, Proc. Roy. Soc., Queensland. 1911. p. 207.
1912*a* Johnston & Harrison, Proc. Roy. Soc., Q'land. 1912, pp. 1—16.
1912*b* Johnston & Harrison, the present paper.
1908. Lea, Insect and Fungus Pests, etc., Edit. 3, Hobart.
1902. Le Souef, Victorian Naturalist, xix., 1902.
1767. Linnæus, Syst. Nat., II.
1910. Mjoberg, Arkiv. f. Zoologi., VI, (13).
1818. Nitzsch, in Germar's Mag. d. Entomol.
1891. Osborn, Bull. 7., Dept. Agr., Entomol. Div., U.S.A.
1880. Piaget, Les Pediculines, Leiden.
1895. Railliet, Traité de Zool. Agric. Medic., Paris.
1882. Taschenberg, Nova Acta. XLIV. (1), 1882.

*Froggatt (1907), refers to some of Piaget's and Le Souef's species, but does not add any information regarding Australian Mallophaga, either native or introduced.

SUPPLEMENT TO THE LICHEN FLORA OF QUEENSLAND.

By JOHN SHIRLEY, D.Sc.

Read before the Royal Society of Queensland, May, 1912.

The Lichen Flora of Queensland was published in 1888-9. Parts I-III (*b*) appeared in Volumes V and VI, of the Proceedings of the Royal Society of Queensland, Part IV, with Index and Supplement, was printed by Messrs. Pole & Outridge, in 1889. Since that time, a period of twenty-three years, many additional lichens have been recorded from this State by Dr. Jean Muller, of Geneva; Dr. Chas. Knight, of New Zealand; Dr. James Stirton, of Glasgow; Rev. F. R. M. Wilson, and the author of this paper.

These additions have been described in various scientific journals of Europe and Australia, and many have been recorded by our Government Botanist in his Bulletins, or in Extracts from the Queensland Agricultural Journal, 1890-1912. In these the sections dealing with lichens were of my drafting.

As many Queensland lichens are recorded under incorrect names, and not infrequently under wrong genera, a revision is necessary, and as the Australian student cannot consult the whole of the works, a summary is required. This paper is an attempt to meet both these requirements.

The reference following the name of each species gives to the student the name of an Australian publication in which a description may be found, with the habitat of the type specimen, and a means of obtaining other information.

The classification is that of Dr. Jean Muller, of Geneva, who adopted the distinguishing title of Muller of Aargau, for which the abbreviation M.A. is used.

LICHENS.

COLLEMACEÆ, Mull. Arg. Enum. Lich. Gen., p. 18, and Lich. Socot.

I. COLLEMEÆ, Körb., Par., p. 48.

1. *Obryzum*, Wallr. These are lichens parasitic on species of Collemeæ, and are now referred to Pyrenocarpeæ. Lich., Great Brit., ii., 264-5.
   O. myriopus f. isidiosum, Wilson. s. *Coccocarpia pellita v. incisa*, M.A., Bot. Bull. viii., 97.

2. *Synechoblastus*, Trev.
   S. nigrescens, Huds. s. *Collema nigrescens*, Huds., Lich. Fl. Q., p. 5.
   S. glaucophthalmus, M.A. s. *C. leucocarpum*, Tayl., Lich. Fl. Q., p. 6.
   S. microcarpus, M.A. s. *C. microcarpum*, M.A., Lich. Fl. Q., p. 6.
   S. Gwytheri, Shirley. s. *C. Gwytheri*, Stirton, Q.A.J., Nov., 1899.

3. *Physma*, Mass., Neag., p. 8.
   P. byrsinum, M.A. s. *C. byrsinum*, Ach., Lich. Fl. Q., p. 5.
   P. byrsinum v. amphiurum, M.A., Bot. Bull. iv., 23.

4. *Collema*, Ach. (pro p.)
   C. hypolasium, Stirton, Q.A.J., Nov., 1899.

5. *Leptogium*, Fr. (pro p.)
   L. bullatulum, M.A., Bot. Bull., iv., 23.
   L. cœrulum, Wils., Bot. Bull. ii., p. 28.=*Coccocarpia aurantiaca*, Bot. Bull., viii., p. 97.
   L. Wilsoni, Shirley=*L. denticulatum*, Wils., a name already used by Nylander, Lich. Mey., 41. (See Bot. Bull. ii., 28.)
   L. sphinctrinum, Nyl., Bot. Bull. ii., 28.
   L. atro-viride, Wils., Bot. Bull. ii., 28.
   L. phyllocarpum v. isidiosum, Nyl., Bot. Bull. iii., 20.
   L. phyllocarpum v. dœdalum, Nyl., Bot. Bull. v., 31.
   L. tremelloides v. azureum (Ach.), Mnt., Bot. Bull. iii., 20.
   L. tremelloides v. isidiosa, M.A., Bot. Bull. viii., 91.
   L. chloromelum, Nyl., Bot. Bull. iii., 20.
   L. hypotrachynum, M.A., Lich. Beit. xii., 12.

6. *Leptogiopsis*, M.A., L.B., 372.
   L. carneolum (Wils.), Shirley, Bot. Bull. ii., 28.

1. MYRIANGIUM, Mnt. et Berk.

Now referred to Fungi. Lich. Fl., Great Brit., ii., 263.

II. EPICONIACEÆ, M.A., Enum. Lich. Gen., p. 18; and Lich. Socot.

I. CALICIEÆ, Mull. Arg. Enum. Lich. Gen., p. 19.

1. *Trachylia*, Fries.
   T. tricincta, Wils., Bot. Bull., ii., 31.

2. *Pyrgillus*, Nyl.
   P. javanicus, Nyl. = *P. australiensis*, Wils., Bot. Bull., ii., 31, and *Calicium stenosporum*, Wils., Bot. Bull., ii., 29.

   P. caliciisporus, Wils., Bot. Bull., ii., 31.

   P. fallax, Wils., Bot. Bull., ii., 31.

3. *Acolium* (Fee), De Not.
   A. buelliaceum, M.A., Bot. Bull., viii., 91.

4. *Calicium*, Ach.
   C. trachelinum, Ach. = *C. glebosum v. glaucescens*, Wils. = *C. glebosum v. concinnum*, Wils, and *C. hymenosporum*, Wils., Bot. Bull., ii., 30; Bot. Bull., viii., 91.
   C. trachelinum v. queenslandiæ, Wils., Bot., Bull., ii., 30.
   C. glebosum, M.A., Bot. Bull., v., 31.
   C. pachypus, M.A., Bot. Bull., iv., 23.
   C. chlorosporum, Wils., Bot. Bull., ii., 29.
   C. fulvo-fuscum, Wils., Bot. Bull., ii., 29.
   C. atro-nitescens, Wils., Bot. Bull., ii., 30.
   C. victoriæ, C.K., *v. albo-carneum*, Wils., Bot. Bull., ii., 30.
   C. victoriæ, C.K., *v. jejunum*, Wils., Bot. Bull., ii., 30.
   C. pretenue, Wils., Bot. Bull., ii., 30.
   C. quercinum v. lenticulare, Ach., Q.A.J., Nov., 1899.
   C. curtum, Borr., Lich. Fl. Q., p. 184.

III. LICHENACEÆ, Mull. Arg. Lich. Soc., and Enum. Lich. Gen., p. 18.

I. SPHEROPHOREÆ, M.A., Lich. Miy., p.120.

1. *Sphærophoron*, Pers.
   S. australe, Laur., Bot. Bull., iii., 20.

II. TYLOPHOREÆ, Nyl., Prod. Lich. Nov. Gran., p. 430 as TYLOPHOREI.

2. *Tylophoron*, Nyl., Prod. Lich. Nov. Gran., p. 430.
   T. triloculare, M.A., Bot. Bull., viii., 92.

III. *CLADONIEÆ, M.A., Enum. Lich. Gen., p. 22.

3. *Stereocaulon*, Schreb.
   S. proximum v. nudatum, M.A., Bot. Bull., iii., 21.
   S. ramulosum v. microcorpoides, M.A., Bot. Bull., v., 31.
4. *Thysanothecium*, Berk et Mnt.
   T. Hookeri, Berk et Mnt., Q.A.J., Nov., 1899.
5. *Cladonia*, Hffm.
   s. *Phæocarpæ*.
   C. fimbriata v. antilopæa, M.A., Bot. Bull., iii., 21; viii., 92.
   C. fimbriata v. tenella, M.A., Lich. Fl. Q., p. 184. =*C. delicata*, Wilson, non. Flk.
   C. fimbriata v. chordalis, Flk., Q.A.J., Nov., 1899.
   C. fimbriata v. radiata, Fr. Lich. Fl. Q., p. 184.
   C. cariosa, Flk.=*C. degenerans*, Fr., Q.A.J., Nov., 1899.
   C. degenerans v. pleolepis, Flk., Bot. Bull., viii., 93.
   C. elegantula, M.A.=*C. lepidula*, Kremp. of Lich. Fl. Q., p. 16.
   C. furcata v. foliolosa, M.A., Bot. Bull., viii., 93.
   C. ochrochlora v. ceratodes, Flk., Bot. Bull., iv., 23.
   C. rangiformis v. servediophora, Wain., Bot. Bull., iv., 23.
   C. squamosula, M.A., Lich. Fl. Q., p. 184.
   s. *Erythrocarpæ*.
   C. macilenta v. flabellulata, M.A., Bot. Bull., viii., 93.

IV. THAMNOLIEÆ, Mull. Arg., Lich. Miy., p. 121.

6. *Thamnolia*, Sch.
   T. vermicularis, Sw., Bot. Bull., v., 31.

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*Given as an order of Lecideei in Lich. Flor. Great Brit. II, 2.

v. USNEÆ, Th. M. Fries., Gen. Heter, p. 50 .

7. *Usnea*, Hffm.

U. barbata v. asperrima, M.A.=*Eumitria Baileyi*, Stirton, B.B., iii., 21.

U. barbata v. hirta, Fr.=*U. florida v. articulata*, Stirton, B.B., iii., 21.

U. barbata v. scabrida (Tayl.), M.A., Bot. Bull., iii., 21.

U. barbata v. strigosa, Krph.=*U. florida v. strigosa*, Stirton, B.B., iii., 21.

U. sublurida, Stirton, Q.A.J., Nov., 1899.

vi. RAMALINEÆ, Th. M. Fries., Gen. Hetero., p. 50.

8. *Alectoria*, Ach.

A. australiensis, C.K., transferred to Fungi, having no gonidia. Bot. Bull., viii., 91.

9. *Ramalina*, Ach.

R. gracilis, Nyl.=*R. geniculata*, Hook. et Tayl. (none perforate part), Lich. Fl. Q., p. 196. *R. maculata* M.A., *R. exiguella*, Stirt., *R. costata*, Mey. et Flot.

R. Ecklonii, Mnt.=*R. Yemensis*, Ach., Lich. Fl. Q., p. 196.

R. Ecklonii v. tenuissima, Mey. et Flot., Bot. Bull., viii., 93.

R. Ecklonii v. membranacea (Mnt.), Laur., Bot. Bull., iii., 22

R. Ecklonii v. ovalis, Tayl., Q.A.J., Nov., 1899.

R. dendriscoides, Nyl., Bot. Bull., iii., 22.

R. dendriscoides v. minor, M.A., Bot. Bull., iii., 22.

R. farinacea v. squarrosa, M.A., Lich. Fl. Q., p. 185.

R. fraxinea v. tæniæformis, Ach., Lich. Fl. Q., p. 185.

R. inflata, Hook. et Tayl., Lich. Fl. Q., p. 185.

R. inflata v. gracilis, M.A., Lich. Fl. Q., p. 186.

R. inflata v. olivacea, M.A., Bot. Bull., viii., 93.

R. leiodea, Nyl., Bot. Bull., iii., 22.

10. *Platysma*, Hoffm.

P. eriophyllum, C.K.=*Erioderma Knightii*, Shirley.

vii. PELTIGEREÆ, M.A., Lich. Gen., p. 29.

11. *Peltigera*, Hoffm.

P. polydactyla v. dissecta, M.A., Bot. Bull., viii., 93.

12. *Nephromium*, Nyl.

N. tropicum, M.A., Lich. Beit., 559.

VIII. PARMELIEÆ, Mull. Arg., Lich. Parag., p. 3; and Lich. Gen., p. 31.

13. *Stictina*, Nyl.

S. argyracea f. isidiosa, M.A., Bot. Bull., iv., 24.

S. punctillaris, M.A., Bot. Bull., iv., 24.

S. fragillima v. linearis, M.A., Lich. Fl. Q., p. 188.

S. fragillima v. dissecta, M.A.=*S. fragillissima*, Kremp.

S. intricata, Stirton (non Del.)=*S. crocata v. esorediata*, M.A., Bot. Bull., iii., 23; Bot. Bull., viii., 94.

S. intricata v. Thouarsii, Nyl.=*S. pustulosa*, Wilson.

S. cinnamomea, Rich.=*S. fragillima*, Nyl., Lich. Fl. Q., p. 196.

S. impressula, M.A., Lich. Fl. Q., p. 189.

S. impressula v. sublævis, M.A., Bot. Bull., iv., 24.

S. suborbicularis, M.A.=*S. subtomentella*, C.K., and *S. macrophylla*, of various authors. Bot. Bull., viii., 94.

S. quercizans, Ach.=*S. tomentella*, Leighton (non Ach.), Bot. Bull., viii., 94.

S. cyphellulata, M.A., Lich. Fl. Q., p. 189.

S. fuliginosa, Nyl., Bot. Bull., viii., 94.

S. brevipes, M.A.=*S. marginifera*, Tayl., Lich. Fl. Q., p. 55; Bot. Bull., viii., 94.

S. retigera, M.A.=*Lobaria retigera*, Ach., Lich. Beit., 74.

14. *Sticta*, Ach.

S. pulmonacea, M.A.=*Lobaria pulmonacea*, Ach., Lich. Fl. Q., p. 57.

S. variabilis v. papyracea, M.A., Bot. Bull., viii., 94.

S. demutabilis, Krph., Bot. Bull., iii., 23.

S. carpolomoides, Nyl., Bot. Bull., iii., 23.

S. dichotomoides, Nyl.=*S. stipitata*, Wils., and *S. camaræ*, M.A., Lich. Fl. Q., p. 196.

S. Sayeri, M.A., Lich. Fl. Q., p. 191.

S. Seemanni, Bab., Bot. Bull., viii., 94.

S. filix v. myrioloba, M.A., Bot. Bull., v., 31.

S. glaucescens, Krph., Bot. Bull., iii., 23.

S. aurata v. microphylla, M.A., Lich. Fl. Q., p. 190.

S. endochrysea v. flavicans, M.A.=*S. flavicans*, Hook. et Tayl., Bot. Bull., viii., 94.

S. Richardi, Hook., to be separated from *S. Billardieri*, Del., Lich. Fl. Q., p. 62; Lich. Beit, 566.

S. sulphurea, Schaer, Lich. Fl. Q., p. 190.
S. Karstenii, M.A., Lich. Fl. Q., p. 190.
S. Karstenii v. linearis, M.A., Lich. Fl. Q., p. 191.
S. impressa, Hook. et Tayl.=*S. physciospora*, Nyl., and *S. Bornetii*, M.A., Bot. Bull., viii., 94.

15. *Riascolia*, De Not.

R. erosa, Eschw., Q.A.J., Nov., 1899.
R. Ravenelii, Tuck., Q.A.J., Nov., 1899.
R. patinifera, M.A., Lich. Fl. Q., p. 191.
R. hypoleuca, M.A.=*S. hypoleuca*, M.A., Lich. Fl. Q., p. 192.

16. *Parmelia*, Ach.

P. tinctorum, Despr.=*P. euplecta*, Stirton, Lich. Fl. Q., p. 36; and *P. prætervisa*, M.A., Bot. Bull., iii., 23.
P. cetrarioides, Del., Queens. Ag. Jour., Nov., 1899.
P. laceratula v. minor, Shirley, Bot. Bull., v., 32.
P. tenuirima, Tayl., Bot., Bull., viii., 95.
P. tenuirima v. corallina, M.A., Lich. Fl. Q., p. 186.
P. latissima v. ciliata, Nyl., Bot. Bull., iii., 23.
P. latissima, Fee.=*P. platycarpa*, Stirton, Lich. Fl. Q., p. 39.
P. hypoxantha, Stirton, Q.A.J., Nov., 1899.
P. placorhodioides, Nyl., Q.A.J., Nov., 1899.
P. cetrata v. sorediifera, Wain., Bot. Bull., viii., 94.
P. corrugis v. sorediata, M.A., Bot. Bull., iii., 24.
P. perforata, Ach.=*P. reparata*, Stirton, Lich. Fl. Q., 40.
P. perforata v. ciliata, Nyl., Bot. Bull., iii., 24.
P. encausta, Ach., Q.A.J., Nov., 1899.
P. perlata v. ciliata, D.C., Bot. Bull., viii., 95.
P. perlata v. olivaria, Ach., Bot. Bull., iii., 24.
P. Hookeri, Tayl., Bot. Bull., viii., 95.
P. tiliacea v. affixa, Strn., Q.A.J., Nov., 1899.
P. tiliacea v. rugulata, M.A., Bot. Bull., iv., 24.
=*P. caperatula*, Stirton (non Nyl.), Bot. Bull. viii., 95.
P. tiliacea v. stenophylla, M.A., Lich. Fl. Q., p. 186.
P. tiliacea v. sulphurosa, Tuck., Bot. Bull., viii., 95.
P. meizospora, Nyl.=*P. tiliacea v. meizospora*, Nyl., Bot. Bull., viii., 95.
P. pruinata, M.A., Lich. Fl. Q., p. 188.

P. prætervisa, M.A.=*P. tinctorum*, Despr., Bot. Bull., viii., 95.

P. conspersa f. exasperata, M.A., Lich. Fl. Q., p. 188.

P. conspersa v. hypocleistoides, M.A., Bot. Bull., iii., 24.

P. adpressa, Krph.=*P. amplexula*, Stirton, Bot. Bull., viii., 95.

P. rutidota f. sorediosa, M.A., Bot. Bull., viii., 95.

P. limbata v. endococcinea, M.A., Lich. Fl. Q., p. 186.

P. gracilis, M.A., Lich. Fl. Q., p. 187.

P. limbata, Laur.=*P. insinuata*, Knight (non Nyl.), Bot. Bull., viii., 95; Lich. Fl. Q., p. 47.

P. virens, M.A., Lich. Fl. Q., p. 187.

P. virens v. serediata, M.A., Lich. Fl. Q., p. 188.

P. hypoxantha v. major, M.A., Lich. Fl. Q., p. 187.

P. hospitans, M.A., Lich. Fl. Q., p. 188.

P. eciliata, Nyl., Bot. Bull., v., 32.

P. physodes v. pulverata, M.A., Bot. Bull., viii., 95.

P. urceolata v. sorediifera, M.A., Bot. Bull., v., 32.

P. urceolata v. subcetrata, M.A., Bot. Bull., v., 32.

17. *Theloschistes*, Norm. (*Pseudophyscia*, Lich. Beit., 1503).

T. chrysophthalma v. leucoblephara, M.A.=*T. velifer*, Wils., Lich. Fl. Q., p. 193, as Physcia.

T. flavicans v. croceus (Ach.), Nyl., Bot. Bull., iii., 24, as Physcia.

18. *Anaptychia*, Körb., Fl. 1861, p. 32.

A. barbifera, Nyl.=*P. barbifera*, Nyl., Lich. Fl. Q., p. 71.

A. comosa, Trev.=*P. comosa v. alata*, Wils, and *Theloschistes comosa v. alata*, Shirley, Bot. Bull., ii., 32.; Bot. Bull., v., 32; Bot. Bull, viii., 95-6.

A. leucomelæna, Trev.=*P. leucomela*, Lich. Fl. Q., p. 70, Bot. Bull., viii., 95-6.

A. speciosa v. hypoleuca f. sorediifera, M.A., Bot. Bull., viii., 95-6.

A. speciosa v. sorediosa, M.A., Bot. Bull., viii., 95-6.

A. obesa v. caesio-crocata, Tuck., Lich. Fl. Q., p. 71, as Physcia.

19. *Physcia*, Fr. (pro. p.)

P. picta v. isidiophora, Nyl., Bot. Bull., iii., 24.

P. picta v. sorediata, M.A., Bot. Bull., iv., 24.

IX. PYXINEÆ, M.A., Lich. Parag., p. 6; Bot. Soc., p. 356.

20. *Pyxine*, Fr.
P. endochrysina, Nyl., Bot. Bull., viii., 96.
P. cocoes v. endoxantha, M.A., Bot. Bull., iii., 24.
P. meissneri v. endoleuca, M.A., Bot. Bull., viii., 96.
P. meissneri v. sorediosa, M.A., Bot. Bull., viii. 96.

X. PSOROMEÆ, Nyl., Syn. II., 21 (ex. Gymnoderma), and M.A., Lich. N.Z., p. 41.

21. *Psoroma*, Fr.
P. pholidotum, M.A.=*Pannaria pholidota*, Nyl., Lich. Fl. Q., p. 196.
P. sphinctrinum, Nyl.=*P. contortulum*, Wils.
P. cæsium, M.A., Lich. Fl. Q., p. 193.
P. Karstenii, M.A., Lich. Fl. Q., p. 193.

XI. PANNARIEÆ, Körb., Syst., p. 105.

22. *Pannaria*, Del.
P. mariana=*P. pannosa*, Nyl.=*P. cervina*, Kremp., Lich. Fl. Q., p. 78; Lich. Beit., 243; Lich. Beit, 1159; Lich. Fl. Q., p. 196.
P. elatior, Stirton, Q.A.J., Nov., 1899.
P. terrestris, Stirton, Q.A.J., Nov., 1899.
P. mariana f. isidiosa, M.A.=*P. pannosa f. isidioidea*, M.A., Bot. Bull., viii., 96.
P. fulvescens, Mnt., Lich. Fl. Q., p. 193.
P. brisbanensis, C.K., Lich. Fl. Q., p. 194.
P. sordida, C.K., Lich. Fl. Q., p. 194.

23. *Heppia*, Nyl.
H. brisbanensis, Wilson. Bot. Bull., ii., 32.

24. *Erioderma*, Fee, Lich. Schenk. —.
E. Knightii, Shirley=*Platysma eriophyllum*, C.K., Bot. Bull., viii., 96.

XII. PARMELIELLEÆ, M.A., Lich. Cath., p. 239.

25. *Parmeliella*, M.A., Enum. Lich. Gen., p. 36.
P. triptophylla, M.A.=*Pannaria triptophylla*, Ach., Lich. Fl. Q., p. 80.
P. nigro-cincta, M.A.=*Pannaria nigro-cincta*, Mnt., Lich. Fl. Q., p. 81.

XIII. COCCOCARPIEÆ, M.A., Lich. Schenk.

26. *Coccocarpia*, Pers.
C. molybdæa, Pers., Q.A.J., Nov., 1899.
C. pellita v. incisa, M.A., Bot. Bull., viii., 97.
C. pellita v. isidiophylla, M.A., Bot. Bull., iv., 24.
C. pellita v. smaragdina, M.A.=*C. smaragdina*, Pers., Bot. Bull., viii., 97.

XIV. PLACODIEÆ, M.A., Enum. Lich. Gen., p. 37.

27. *Amphiloma*, Fr.
A. murorum, M.A. = *Placodium murorum*, Korb. Lich., Fl. Q., p. 85.

28. *Placodium*, D.C.
P. clavigerum, Stirton, Q.A.J., Nov., 1899.
P. galactinum v. dispersum, Pers., Bot. Bull., iii., 25.
P. glauco-lividum, M.A., Bot. Bull., iv., 24.

XV. PSOREÆ, M.A., Lich. Parag., p. 8.

29. *Phyllopsora*, M.A.
P. breviuscula, M.A.=*Psora parvifolia*, Tuck., Bot. Bull., iii., 25 ; and *P. foliata v. atro-virens*, C. K.
P. foliata, Stirton, Lich. Fl. Q., p. 105, as Lecidea.

30. *Psora*, M.A.
P. parvifolia, M.A.=*Lecidea parvifolia*, Pers., Lich. Fl. Q., p. 106.
P. parvifolia v. fibrillifera, Nyl., Bot. Bull., v., 33.
P. parvifolia v. subgranulosa, M.A., Bot. Bull., viii., 97.
P. subhyalina, Shirley=*Lecidea subhyalina*, Stirton, Lich. Fl. Q., p. 106.

31. *Thalloidima*, M.A.
T. caeruleo-nigricans, M.A.=*L. caeruleo-nigricans*, Lghtf., Bot. Bull., viii., 97.

XVI. LECANOREÆ, M.A., Lich. Socot., p. 359.

32. *Lecanora*, Ach.
s. *Eulecanora*, M.A.
L. lacteola, M.A., Bot. Bull., viii., 97.
L. subfusca v. cinereo-carnea, Tuck., Bot. Bull., viii., 98.
L. subfusca v. conjungens, M.A., Bot. Bull., xiii., 19.
L. subfusca v. compacta, M.A., Bot. Bull., iii., 25.
L. subfusca v. allophana, Ach., Bot. Bull., iii., 25.
L. subfusca v. distans, Nyl., Bot. Bull., viii., 97.

L. subfusca v. subgranulata, Nyl., Bot. Bull., iv., 25.
L. subfusca v. testaceo-pallida, M.A., Bot. Bull., viii., 97.
L. subpurpurea, Strn., Q.A.J., Nov., 1899.
L. granifera, Ach. (non Krph.), Bot. Bull., iii., 25.
L. caesio-rubella, Ach., Bot. Bull., iii., 25.
L. interjecta, M.A., Bot. Bull., iv., 25 ; viii., 98.
L. connivens, M.A., Bot. Bull., iv., 25.
L. atra v. serialis, M.A., Bot. Bull., xiii., 19.
L. albellaria, M.A., Bot. Bull., xiii., 19.
L. flavido-fusca, M.A., Bot. Bull., xiii., 20.
L. Knightiana, M.A., Bot. Bull., xiii., 20.
L. melacarpella, M.A., Bot. Bull., xiii., 20.
L. rhodophthalma, M.A., Bot. Bull., v., 32.
s. *Aspicilia*, M.A.
A. impressa, Kremp.=*Lecanora lævissima*, C.K., B.B., viii., 99.
A. melanommata, C.K.=*Lecanora melanommata*, C.K., L.F.Q., p. 91.
s. *Ochrolechia*, Mass., for s. *Lecanorastrum*, L.F.Q., 94.

33. *Lecania*, Mass., Lich. Scand., p. 11.
L. phæoplaca, Strn., Q.A.J., Nov., 1899.
L. punicea, M.A.=*Lecanora punicea*, Ach., Lich. Fl. Q., p. 93.

34. *Callopisma*, De Not.
C. cinnabarinum v. opacum, M.A., Bot. Bull., viii., 98.
C. conjungens, M.A., Bot. Bull., viii., 98.
C. rubens, M.A., Bot. Bull., iv., 25.

35. *Rinodina*, M.A.
R. xanthomelana, M.A., Bot. Bull., iv., 25.
R. diffractella, M.A., Bot. Bull., iv., 25.
R. rhypoderma (M.A.), Shirley, Bot. Bull., iv., 25 ; Lich. Brisb., 51.
R. minutula, M.A., Bot. Bull., iii., 26.

36. *Pertusaria*, D.C.
P. albinea, M.A., Bot. Bull., xiii., 22.
P. amblygona, M.A., Bot. Bull., xiii., 21.
P. commutata, M.A., Bot. Bull., viii., 98.
P. confluens, M.A., Bot. Bull., xiii., 22.
P. depressa v. octomera, M.A., Bot. Bull., viii., 98.
P. elliptica, M.A., Bot. Bull., xiii., 21.

P. globulifera, Nyl., Bot. Bull., viii., 98.
P. irregularis, M.A., Bot. Bull., xiii., 22.
P. leucoxantha, M.A., Bot. Bull., xiii., 21.
P. lactea, Nyl. = *P. sorediata*, C.K., Bot. Bull., viii., 98.
P. leiocarpella, M.A., Bot. Bull., xiii., 21.
P. leioplaca v. gibbosa, M.A., Bot. Bull., v., 33.
P. leioplaca v. octospora, Nyl., Bot. Bull., v., 33.
P. leucostoma, M.A., Bot. Bull., xiii., 21.
P. macra, M.A., Bot. Bull., xiii., 22.
P. meridionalis v. xanthostoma, M.A., Bot. Bull., iii., 26.
P. multipuncta, Turner, Q.A.J., Nov., 1899.
P. persulphurata, M.A., Bot. Bull., iv., 25.
P. plicatula, M.A., Bot. Bull., xiii., 21.
P. rhodotropa, M.A., Bot. Bull., xiii., 20.
P. straminea, M.A., Bot. Bull., xiii., 22.
P. sulphurata, M.A., Bot. Bull., viii., 98.
P. subvaginata, Nyl., Bot. Bull., iii., 26.
P. subrigida, M.A., Bot. Bull., xiii., 21.
P. Wulfenii, D.C., Bot. Bull., iii., 27.

37. *Diploschistes*, Norm. (*Urceolaria*, Ach.)
D. actinostomus, Zahl = *Urceolaria actinostoma*, Schær., Bot. Bull., iii., 26; and *Lecidea clausa*, C.K., Lich. Fl. Q., p. 123.

XVII. GYALECTEÆ, M.A. Lich. Parag., p. 12.

38. *Gyalectidium*, M.A.
G. phyllocharis, M.A. = *L. phyllocharis*, Mnt., Lich. Fl. Q., p. 115; Bot. Bull., viii., 99.
G. filicinum, M.A., Bot. Bull., viii., 99.

XVIII. LECIDEÆ, M.A., Enum. Lich. Gen., p. 50.

39. *Lecidea*, Ach.
s. *Eulecidea*.—Apothecia lecideine; spores, 8, simple; hypothecium coloured.
L. ferax, M.A., *v. geographica*, M.A. Bot. Bull., xiii., 23.
L. albo-cœrulescens, Wulf. = *L. subnubila*, Stirton, Lich. Fl. Q., p. 108; Bot. Bull., viii., 99.
L. cinerascens, A.L.S., = *L. speirea*, Ach., Lich. Fl. Gt. Brit., ii., 73.
s. *Lecidella*.—Apothecia lecideine; spores 8, simple; hypothecium hyaline.

L. angolensis, M.A., Bot. Bull., iii., 27.
s. *L. ocellifera*, Nyl., Lich. Jap., p. 70.
L. nesophila, M.A., Bot. Bull., xiii., 23.
s. *Biatora*.—Apothecia biatorine, spores 8, simple.
L. aspidula v. dispersa, M.A., Bot. Bull., xiii., 22.
L. insulana, M.A., Bot. Bull., xiii., 22.
L. exigua, Chaub., Bot. Bull., iii., 27.
L. impressa, Krph., Bot. Bull., iii., 27; given as *Lecidella*, Lich. Cost. Ric., ii., 18.
L. impressa v. angulosa, M.A., Bot. Bull., iv., 26.
L. leptoloma, M.A., Bot. Bull., iii., 27.
L. piperis, Spreng., Lich. Fl. Q., p. 194.
L. piperis v. melanocarpa, M.A., Bot. Bull., viii., 100.
s. *Biatorella*, M.A., Apothecia biatorine, spores numerous, simple.
L. hæmatina, M.A., Bot. Bull., iv., 26.

40. *Patellaria*, M.A.
s. *Biatorina*.—Apothecia biatorine, spores small, uniseptate.
P. melaclina, M.A., Bot. Bull., viii., 100.
s. *Psorothecium*.—Apothecia lecideine-biatorine; spores large, uniseptate.
P. flavicans, M.A., Bot. Bull., iv., 26.
P. melanodermia, M.A., Bot. Bull., iv., 26.
P. Taitensis v. epiglauca, Nyl., Bot. Bull., v., 33.
s. *Catillaria*.—Apothecia lecideine-biatorine, finally convex and immarginate, spores 8, uniseptate.
P. albo-flavicans, M.A., Bot. Bull., viii., 100.
s. *Bilimbia*.—Apothecia lecideine-biatorine; spores 3 to many-celled, finger or rod-shaped.
P. nodulosa, Shirley. s. *L. nodulosa*, Stirton Q.A.J., Nov., 1899.
P. sphæroides, Dicks., Bot. Bull., v., 33.
P. leucoblephara, Nyl., Lich. Fl. Q., p. 195.
P. triseptata, Hepp., Bot. Bull., iii., 27.
P. luteola v. conspondens, Nyl., Q.A.J., Nov., 1899.
P. vinicolor, Shirley. s. *L. vinicolor*, Stirton, Q.A.J., Nov., 1899.
s. *Bombyliospora*.—Apothecia lecideine-biatorine; spores shaped and divided like a bee's body; 5 to many-septate.

P. fusco-luteum, M.A. = *L. fusco-lutea*. Dicks., L.F.Q., p. 115.

P. domingensis v. inexplicata, M.A., Bot. Bull., iii., 28.

P. vulpinum, Tuck. = *L. domingensis v. gyrosa*, Stirton, Lich. Fl. Q., p. 117.

s. *Bacidia*.—Spores acicular, 3 to pluriseptate.

P. intermixta. M.A., Bot. Bull., viii., 100.

P. millegrana, M.A., Bot. Bull., viii., 100.

P. millegrana v. fusco-nigrescens, M.A., Bot. Bull., viii., 100.

P. rhodocardia, M.A., Bot. Bull., iv., 26.

P. entodiaphana, C.K., Bot. Bull., iii., 28.

s. *Scoliosporum*.—Spores blunt at one end and pointed at the other, 3 to pluriseptate.

P. multiseptata, Shirley. Bot. Bull., v., 33.

41. *Blastenia*, M.A.

B. ochroleuca, M.A., Bot. Bull., xiii., 23.

41 (a) *Buellia*, De Not. Spores brown, bilocular.

B. rimulosa, M.A., Bot. Bull., viii., 101.

B. subareolata, M.A., Bot. Bull., viii., 100.

B. subarenaria, M.A., Bot. Bull., viii., 100.

B. lactea, Körb., Bot. Bull., iii., 29.

B. parasema v. rugulosa, Körb., Bot. Bull., iii., 28.

B. parasema v. saprophila, Körb., Bot. Bull., iii., 28.

B. parasema v. vulgata, Th. Fr., Bot. Bull., iii., 28.

B. tetrapla, M.A., Lich. Fl. Q., Shirley : Lich. War., p. 3.

B. tetrapla v. nigro-cincta, M.A., Bot. Bull., v., 33.

B. modesta, M.A., Bot. Bull., iii., 28.

B. amblygona, M.A., Bot. Bull., xiii., 23.

B. innata, M.A., Bot. Bull., iii., 29.

B. lauri-cassiæ, Fee., Bot. Bull., iii., 28.

B. macrosporoides, M.A., Bot. Bull., xiii., 23.

B. placomorpha, Stirton, Q.A.J., Nov., 1899.

B. sanguinolenta. Shirley = *L. sanguinolenta*, Stirton, Q.A.J., Nov., 1899.

B. glomerella. Shirley = *L. glomerella*, Stirton. Q.A.J., Nov., 1899.

42. *Heterothecium*, Flot. (pro. p. Mass.)

H. vulpina, Tuck. s. *L. domingensis v. gyrosa*, Stirton, Lich. Fl. Q., p. 117 · Bot. Bull., viii., 101.

H. vulpinum v. corallinum, M.A., Bot. Bull., iv., 27.

H. vulpinum v. glaucescens, Nyl., Bot. Bull., v., 33.

H. fusco-luteum, M.A. s. *L. fusco-lutea*, Dicks., Lich. Fl. Q., p. 115; Bot. Bull., viii., 101.

H. pulchrum, M.A., Bot. Bull., iv., 27.

H. biferum, M.A., Bot. Bull., v., 34.

43. *Rhizocarpon*, M.A.

R. geographicum v. cyclopicum, Nyl.

S. *L. geographica v. cyclopica*, Nyl., Lich. Fl. Q., p. 123.

XIX. *COENOGONIEÆ, M.A., Lich. Parag., p. 18.

44. *Coenogonium*, Ehrenb.

C. confervoides, Nyl. s. *C. interpositum*, Nyl., Bot Bull., viii., 101.

C. implexum, Nyl., Bot. Bull., iv., 27.

C. moniliforme, Tuck., Bot. Bull., iii., 29.

XX. BIATORINOPSIDEÆ, Mull. Arg., Lich. Parag, p. 18.

45. *Biatorinopsis*, M.A.

B. planella, Nyl., Lich. Fl. Q., p. 196.

B. zonata, M.A., Bot. Bull., iv., 27.

XXI. THELOTREMEÆ, M.A., Graph., Fee., p. 5.

46. *Ocellularia*, M.A., L. B., 365.

O. annulosa, M.A., Bot., Bull., xiii., 24.

O. Baileyi, M.A., Bot. Bull., iv., 29.

O. cricota, Wils. s. *Phaeotrema cricotum*, M.A., Bot. Bull., ii., 32; viii., 102.

O. diffractella, M.A., Bot. Bull., iv., 29.

O. endomelæna, M.A., Bot. Bull., viii., 101.

O. goniostoma, M.A., Bot. Bull., iv., 29.

O. jugalis, M.A., Bot. Bull., xiii., 24.

O. leucotylia, M.A., Bot. Bull., viii., 91.

O. pulchra, M.A., Bot. Bull., iv., 29.

O. phlyctioides, M.A., Bot. Bull., viii., 101.

O. platychlamys, M.A., Bot. Bull., xiii., 24.

O. xantholeuca, M.A., Bot. Bull., iv., 29.

O. zeorina, M.A., Bot. Bull., iv., 28.

47. *Phaeotrema*, M.A., Graph. Fee, p. 10.

P. cricota, M.A. s. *Ocellularia cricota*, Wilson, Bot. Bull., viii., 102.

*In Lich. Fl., Great Brit., II, 2, placed with Lecideæ.

48. *Thelotrema*, M.A., Graph. Fee, pp. 10-11.
   T. albo-coronatum, C.K. s. *T. cupulare*, M.A., Bot. Bull., viii., 102.
   T. argenteum, M.A., Bot. Bull., iv., 28.
   T. bicuspidatum, M.A., Bot. Bull., iv., 28.
   T. cyphelloides, M.A.. Bot. Bull., xiii., 24.
   T. endoxanthum, M.A., Bot. Bull., iv., 28.
   T. inturgescens, M.A.. Bot. Bull., viii., 102.
   T. megalosporum, M.A., Bot. Bull., iv., 28.
   T. microphthalmum, M.A., Bot. Bull.. xiii., 24.
   T. profundum, Shirley, Bot. Bull., xiii., 24.
   T. rimulosum, M.A., Bot. Bull.. iv., 28.

49. *Leptotrema*, M.A., Graph. Fee, p. 12.
   L. æmulum, M.A., Bot. Bull., xiii., 25.
   L. diffractum, M.A., Bot. Bull., iv., 27.
   L. compunctum, Nyl., Bot. Bull., viii., 102.
   L. monosporum, C.K. s. *Thelotrema monosporum*, Shirley, Lich. Fl. Q., p. 131.
   L. nitidulum, M.A., Bot. Bull., xiii., 25.
   L. patulum, M.A., Bot. Bull., xiii., 25.
   L. polycarpum, M.A., Bot. Bull., xiii., 25.

XXII. GRAPHIDEÆ, M.A., Graph. Fee, p. 13., and Bot. Soc., p. 372.

50. *Tremotylium*, M.A.
   T. nitidulum, M.A., Bot. Bull., viii., 103.

51. *Platygrapha*, Nyl.
   P. Shirleyana, M.A., Bot. Bull., xiii., 25.

52. *Opegrapha*, Nyl.
   s. *Euopegrapha*, M.A., Lirellæ lecideine, always oblongate, not thalline-margined; perithecium complete; gonidia chroolepoid.
   O. grossulina, M.A., Bot. Bull., iii., 29.
   O. prosodea, Ach., Bot. Bull., xiii., 26.
   O. interveniens, M.A., Bot. Bull., iv., 30.
   O. Bonplandi v. abbreviata, M.A., Bot. Bull.. viii., 102.
   s. *Lecanactis*, M.A. As in *Euopegrapha*, but lirellæ always when young orbicular, sub-lecideine, at length oblongate, no thalline margin, but often pulverulent; perithecium complete; base incrassate; lips laterally emergent.

O. varia v. diaphora, Nyl., Bot. Bull., viii., 102.
O. vulgata v. subsiderella, Nyl., Bot. Bull., viii., 102.
O. lacteella, M.A., Bot. Bull., xiii., 26.
O. minutula, M.A., Bot. Bull., xiii., 26.

53. *Melaspilea*, M.A.

s. *Holographa*, M.A. Perithecium complete, lips connivent; disk rimiform.

M. operaphoides, Nyl., Lich. Nov. Gran., p. 487, No. 92, as *Opegrapha*.

M. leucina, M.A. s. *O. leucina*, M.A., Lich. Fl. Q., p. 135.

s. *Hemigrapha*, M.A., Perithecium with base wanting; lips connivent; disk rimiform-angulate.

M. asteriscus, M.A., Bot. Bull., iii., 29.

s. *Eumelaspilea*, M.A. Perithecium at the base complete; lips rather small, at length distant or widely gaping; disk wide.

M. congregans, M.A., Bot. Bull., iv., 30.

M. intrusa, M.A. s. *Opegrapha intrusta*, Stirton, Lich. Fl. Q., p. 135.

M. congregantula, M.A., Bot. Bull., xiii., 26.

s. *Melaspileopsis*, M.A., Lich. Parag., p. 20.

M. stellaris., M.A., Bot. Bull., xiii., 26.

54. *Graphis* (Ach.), M.A.

s. *Aulacographa*, M.A. Perithecium black, base complete; lips connivent; longitudinally sulcate; disk rimiform, black.

G. descissa, M.A., Bot. Bull., xiii., 27.
G. rimulosa v. pulverulenta, Nyl., Bot. Bull., iv., 30.
G. rimulosa v. brachycarpa, M.A., Bot. Bull., xiii., 27.

s. *Solenographa*, M.A. Perithecium black, complete, not at all sulcate; disk narrow, black, subrimiform.

G. emersa, M.A., Bot. Bull., viii., 103.

s. *Eugraphis*, M.A. Perithecium black, wanting beneath the lamina; lips connivent, not at all sulcate; disk narrow, commonly rimiform, subnigrous.

G. albissima, M.A., Bot. Bull., xiii., 27.
G. immersella, M.A., Bot. Bull., xiii., 27.

G. Lineola, Ach., Bot. Bull., viii., 103.

G. scripta v. recta, Nyl., Bot. Bull., iv., 31.

s. *Aulacographa*, M.A. Perithecium black, wanting beneath the lamina about the middle part of the lirella: lips connivent, longitudinally sulcate: disk subrimiform and subnigrous.

G. duplicata, Ach., Bot. Bull., viii., 103.

G. duplicata v. sublaevis, M.A., Bot. Bull., viii., 103.

G. vinosa, M.A., Bot. Bull., xiii., 27.

s. *Phanerographis*, M.A. Perithecium complete; disk at length opening widely, plane.

G. semiaperta, M.A., Bot. Bull., iv., 31.

s. *Fissurina*, M.A. Perithecium pallid, more or less erumpent: disk pallid: spores 4-locular.

G. albo-nitens, M.A., Bot. Bull., iv., 30.

G. insidiosa, M.A., Bot. Bull., viii., 103.

G. laevigata, M.A., Bot. Bull., iv., 30.

s. *Chlorographa*, M.A. Perithecium pallid; disk subplane, pallid: loculi of spores more than 4.

G. Baileyana, M.A., Bot. Bull., viii., 103.

s. *Diplographis*, M.A. Lirellæ with lips closely connivent, longitudinally sulcate, not at all black: spores 2-4-locular.

G. robustior, M.A., Bot. Bull., iv., 31.

s. *Mesographis*, M.A. Perithecium sulcate, above black, within coloured: epithecium rimiform.

G. xanthospora, M.A., Bot. Bull., xiii., 27.

55. *Phæographis*, M.A., L. B., 454, 531.

s. *Anisothecium*, M.A., Perithecium black, base wanting: disk subrimiform, narrow.

P. epimelæna, M.A., Bot. Bull., xiii., 28. s. *Graphis malacodes*, Stirton, non. Nyl., Lich. Fl Q., p. 143.

56. *Graphina*, M.A.

s. *Solenographina*, M.A. Perithecium black, complete: lips not sulcate: disk rimiform, black.

G. saxicola, M.A. s. *G. olivaceo-lutea*, C.K., Lich. Fl. Q., p. 145.

s. *Aulacographina*, M.A. Perithecium black, base incomplete, wanting beneath the lamina; lips longitudinally sulcate; disk rimiform, black.

G. sophistica v. recta, M.A., Bot. Bull., xiii., 28.

G. subvelata, Shirley. s. *Graphis subvelata*, Stirton, Q.A.J., Nov., 1899.

G. tenuirima, Shirley. Bot. Bull., v., 34.

s. *Platygrammina*, M.A. Perithecium fuscous or pallid, base wanting; disk widely aperient, subplane, pallid, clothed with a thin thalline vestment.

G. quassiaecola, M.A. s. *Graphina pyelodes*, Wils., Bot. Bull., ii., 32; viii., 103.

s. *Platygraphina*, M.A. Apothecia and disk thickly albido-thalline clothed; perithecium brown or pallid or almost indistinct, base complete, everywhere thin; disk broad, flat, pallid.

G. simulans, M.A., Bot. Bull., iii., 29.

s. *Medusulina*, M.A. Lirellæ gregariously crowded, not subsequently dispersed.

G. egenella, M.A., Bot. Bull., iv., 31.

57. (*a*) *Phæographina*, M.A.

s. *Eleutheroloma*, M.A. Perithecium wanting or hyaline under the lamina, elsewhere black or olivaceo-fuscous or evanescent; lips at length distant, thin; disk wide, subplane, nigro-fuscous.

P. caesio-pruinosa. M.A., Bot. Bull., iii., 20.

P. caesio v. monospora, M.A., Bot. Bull., xiii., 28.

s. *Homoloma*, M.A. Perithecium fusco-nigrous, not sulcate or thalline clothed; base complete, margins thick; disk black and narrow.

P. assimilis, Shirley, Lich. Fl. Q., p. 195.

s. *Chrooloma*, M.A. Lirellæ clothed with thalline stratum, wholly pallid, or golden or brown; margins thick, connivent, beneath the thallus profoundly longitudinally sulcate; disk narrow, pallid.

P. chrysentera, M.A., Bot. Bull., iv., 31.

P. contexta, M.A., Bot. Bull., iv., 32.

57. (*b*). *Helminthocarpon*, Fee.

H. Baileyanum, M.A., Bot. Bull., xiii., 29.

58. *Arthonia*, Ach.

A. albofarinosa, Stirton, Q.A.J., Nov., 1899.

A. amoena, M.A., Bot. Bull., xiii., 29.

A. gracilior, M.A., Bot. Bull., xiii., 29.

A. rubeella, M.A., Bot. Bull., xiii., 29.

A. subgyrosa, Nyl., Bot. Bull., iii., 30.

A. gregaria v. adspersa, Nyl., Bot. Bull., iii., 30.

A. gregaria v. purpurea, Esch., Bot. Bull., iv., 32.

A. leptospora, M.A., Bot. Bull., iv., 32.

59. *Arthothelium*, Mass.

A. cribrosa, Fee., Bot. Bull., iv., 32.

A. favulosa v. depauperata, M.A., Bot. Bull., iv., 32.

A. favulosa v. intermedia, M.A., Bot. Bull., iii., 30.

A. microsporum, M.A., Bot. Bull., xiii., 29.

A. polycarpum, M.A., Bot. Bull., xiii., 29.

A. puniceum, M.A., Bot. Bull., viii., 104.

60. *Mycoporellum*, M.A.

M. perexiguum, M.A., Bot. Bull., iv., 32.

61. *Asterotrema*, M.A.

A. punctuliforme, M.A., Bot. Bull., xiii., 30.

XXIII. GLYPHIDEÆ, M.A.

62. *Sarcographa*, Fee.

S. subtricosa, M.A. s. *S. actincta*, Wils., Bot. Bull., viii., 104.

S. subtricosa v. pulverulenta, Shirley. s. *S. actinota f. pulverulenta*, Wilson, Bot. Bull., ii., 33.

S. oculata, M.A., Bot. Bull., xiii., 30.

63. *Chiodecton*, Ach.

C. endoleucum, M.A., Bot. Bull., viii., 104.

C. hamatum, Nyl., Bot. Bull., xiii., 30.

C. sphærale, Ach. s. *C. stromaticum*, C.K., Lich. Fl. Q., p. 157.

C. virens, M.A., Bot. Bull., xiii., 30.

XXIII. (*a*) XYLOGRAPHIDEÆ, Th. M. Fries.

64. *Diplogramma*, M.A.

D. australiensis, M.A., Bot. Bull., iv., 33.

IV. PYRENOCARPEÆ, M.A., Consp. Syst. N.Z., p. 15.

I. DERMATOCARPÆ, M.A., Pyreno. Cub., p. 377.

1. *Dermatocarpon*, Eschw. Syst., p. 21 (pro. p.)

D. miniatum, Th. M. Fries, Bot. Bull., x., 28.

II. STRIGULEÆ, M.A., Pyr. Cub., p. 378.

2. *Strigula*, Fr.
   S. Glaziovii, M.A., Bot. Bull., iii., 61.
   S. elegans v. eumorpha, M.A., Bot. Bull., viii., 104.
   S. elegans v. pertenius, M.A., Bot. Bull., viii., 104.

III. PYRENULÆ, M.A., Pyr. Cub., p. 381.

Sub-tribe 1. *Astrothelieæ*, Trev., Syn. Gen. Tryp., p. 22.

3. *Parmentaria*, Fee., Meth., p. 24.
   P. astroidea, M.A., Bot. Bull., viii., 104.
   P. Baileyana, M.A., Bot. Bull., x., p. 34.
   P. grossa, M.A., Bot. Bull., x., 35.
   P. interlatens, M.A., Bot. Bull., x., 35.
   P. subastroidea, M.A., Bot. Bull., x., 35.
   P. subastroidea v. subsimplex, M.A., Bot. Bull., x., 35.
   P. toowoombensis, M.A., Bot. Bull., x., 35.

Sub-tribe 2. *Pleurothelieæ*, M.A., Pyr. Cub., p. 387.

4. *Pleurothelium*, M.A., Pyr. Cub., 387.
   P. australiense, M.A., Bot. Bull., iv., 33.

5. *Parathelium*, Nyl., Bot. Zeit., 1862, p. 279.
   P. decumbens, M.A., Bot. Bull., viii., 105.
   P. fibrata, Shirley. s. *Verrucarria fibrata*, Stirton, Q.A.J., Nov., 1899.

6. *Pleurotrema*, M.A., Pyr. Cub., p. 388.
   P. pyrenuloides, M.A., Bot. Bull., x., 15.

7. *Campylothelium*, M.A., Lich. Beit., 595.
   C. defossum, M.A., Bot. Bull., iii., 30, and iv., 33.
   C. nitidum, M.A., Bot. Bull., iii., 30, and iv., 33.

Sub-tribe 3. *Trypethelieæ*, M.A., Pyr. Cub., 389.

8. *Trypethelium*, Trev., Syn. Tryp., p. 19.
   T. anomalum, Ach., Bot. Bull., v., 34.
   T. infuscatum, M.A., Bot. Bull., x., 34.
   T. tropicum v. nigratum, M.A., Bot. Bull., x., 34.
   T. virgineum, M.A., Bot. Bull., x., 34.
   T. eleuteriæ v. citrinum, M.A., Bot. Bull., iii., 30.
   T. oligocarpum, M.A., Bot. Bull., iv., 33.

9. *Bathelium*, Trev. Syn. Gen. Tryp., p. 21.
   B. chrysocarpum, M.A., Bot. Bull., iv., 34.

10. *Bottaria*, Mass., Misc. Lich., p. 42.
   B. umbilicata, M.A. s. *Trypethelium umbilicatum*, C.K., Bot. Bull., x., 34.

11. *Melanotheca*, Fee., Ess. Sup., p. 70.
    M. cruenta, M.A. s. *M. rubra*, C.K., Bot. Bull., x., 34.
    M. oxyspora, M.A., Bot. Bull., x., 34.
    M. subsimplex, M.A., Bot. Bull., iv., 34.

12. *Tomasellia*, Mass., Fl., 1856, p. 283.
    T. aciculifera, M.A., Bot., Bull., iii., 31.
    T. queenslandica, M.A., Bot. Bull., x., 34.

Sub-tribe 4. *Verrucarieæ*, M.A., Pyr. Cub., 398.

13. *Porina*, M.A., Lich. Beit., 644.
    P. africana, M.A. s. *P. limilata*, C.K., Bot. Bull., x., 30.
    P. araucariæ, M.A., Bot. Bull., iv., 34.
    P. bellendenica, M.A., Bot. Bull., iv., 34.
    P. fulvula, M.A., Bot. Bull., xiii., 31.
    P. glauca, M.A., Bot. Bull., x., 30.
    P. internigrans, M.A., Bot. Bull., x., 30.
    P. pallida, M.A., Bot. Bull., xiii., 31.
    P. rudis, M.A., Bot. Bull., x., 30.
    P. rhaphidospora. M.A. s. *Verrucaria rhaphispora*, C.K., Bot. Bull., x., 30.
    P. tetraceræ, M.A., Bot. Bull., x., 30. s. *V. nana*, Stirton.
    P. variegata, Fee., Bot. Bull., x., 30.

14. *Phylloporina*, M.A., Lich. Epiph., No. 50.
    P. epiphylla, M.A., Bot. Bull., x., 30.

15. *Clathroporina*, M.A., Lich. Beit., 541.
    C. desquamans, M.A., Bot. Bull., iv., 34.
    C. desquamans v. sorediifera, M.A., Bot. Bull., viii., 105.
    C. flavescens, M.A., Bot. Bull., iv., 34.
    C. olivacea, M.A. s. *Porina enteroxantha*, C.K., Lich. Fl. Q., p. 171 : Bot. Bull., viii., 105.

16. *Arthopyrenia*, M.A., Lich. Beit., 612.
    A. atomaria, M.A., Bot. Bull., x., 29.
    A. cinchonæ, M.A., Bot. Bull., viii., 105.
    A. consobrina, M.A., Bot. Bull., x., 29.
    A. extans, M.A., Bot. Bull., x., 29.
    A. fallacior, M.A., Bot. Bull., x., 29.
    A. limitans, M.A., Bot. Bull., x., 29.
    A. oculata, M.A., Bot. Bull., x., 29.
    A. suboculata, M.A., Bot. Bull., xiii., 31.

17. *Polyblastia*, M.A., Lich. Beit., 490.
   P. geminella, M.A., Bot. Bull., x., 31.
   P. gregantula, M.A., Bot. Bull., x., 30.
   P. nudata, M.A., Bot. Bull., viii., 105.

18. *Pyrenula*, Fee., Ess. Suppl., p. 76.
   P. adacta, Fee., Bot. Bull., iii., 31.
   P. adacta v. cinerascens, M.A., Bot. Bull., x., 33.
   P. bicuspidata, M.A. s. *V. subvariolosa*, C.K., Bot. Bull., viii., 106.
   P. Bonplandiæ, Fee., Bot. Bull., x. 32.
   P. indusiata, M.A., Bot. Bull., x., 32.
   P. Kunthii., Fee., Bot. Bull., viii., 106.
   P. mastophora (Nyl)., M.A., Bot. Bull., iii., 31.
   P. mastophorizans, M.A., Bot. Bull., x., 33.
   P. marginata, Trev., Bot. Bull., viii., 106.
   P. mamillana, Trev., Bot. Bull., iii., 31.
   P. melaleuca, M.A., Bot. Bull., iv., 34.
   P. microcarpoides, M.A., Bot. Bull., x., 32.
   P. nigro-cincta, M.A., Bot. Bull., iv., 34.
   P. nitida, Ach., Bot. Bull., viii., 106.
   P. nitidans, M.A., Bot. Bull., iv., 34.
   P. oxyspora, M.A., Bot. Bull., x., 32.
   P. pinguis, Fee., Bot. Bull., viii., 106.
   P. pinguis v. emergens, M.A. s. *V. punctella v. exstans*, Nyl., Bot. Bull., x., 33.
   P. porinoides, Ach., Bot. Bull., x., 33.
   P. subcongruens, M.A., Bot. Bull., x., 32.
   P. sexlocularis, M.A. s. *V. subvariolosa*, C.K., B.B., x., 33.
   P. velatoir, M.A., Bot. Bull., x., 32.
   P. Warmingii, M.A., Bot. Bull., iii., 31. s. *V. tropica*, Stirton.*

19. *Anthracothecium*, Mass., Esam. Comp., p. 49.
   A. aurantium, M.A., Bot. Bull., x., 33.
   A. amphitropum, M.A., Bot. Bull., iii., 31.
   A. confine, M.A., Bot. Bull., viii., 106.
   A. denudatum, M.A., Bot. Bull., x., 33.
   A. denudatum v. ochrotropum, M.A., Bot. Bull., x., 33.
   A. Doleschalii, Mass. s. *Trypethelium planum*, C.K., Bot. Bull., viii., 106.
   A. oculatum, M.A., Bot. Bull., iv., 35.
   A. oligosporum, M.A., Bot. Bull., x., 33.

A. pyrenuloides, M.A., Bot. Bull., iii., 32.
A. Thwaitesii, M.A., Bot. Bull., iii., 31.

20. *Microthelia*, Körb., Syst., p. 372.
M. alba, M.A., Bot. Bull., x., 31.
M. brisbanensis, M.A., Bot. Bull., x., 31.
M. maculiformis, M.A., Bot. Bull., iii., 32.
M. obovata, M.A. s. *Pyrenula obovata*, Shirley, Lich. Fl. Q., p. 176.
M. queenslandiæ, M.A., Bot. Bull., x., 31.
M. Shirleyana, M.A., Bot. Bull., x., 31.
M. subgregans, M.A., Bot. Bull., x., 31.

NOTES ON SOME AUSTRALIAN ATHERINIDÆ.

By ALLAN R. McCULLOCH,

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Plate I. and Text Figure 1.

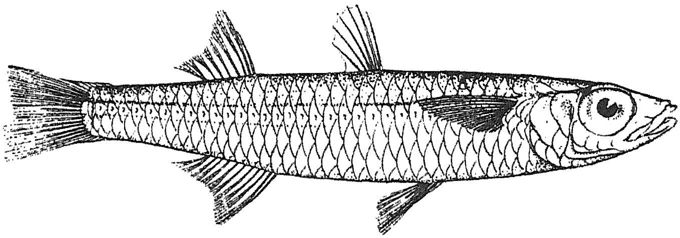
Read before the Royal Society of Queensland, 26th June, 1912.
(Communicated by DR. T. HARVEY JOHNSTON).

ATHERINA MUGILOIDES, *nom. nov.*

(Text Figure 1.)

Atherinichthys punctatus, De Vis, Proc. Linn. Soc. N. S. Wales, IX., 1885, p. 869 (not *Atherina punctata*, Bennett, 1832).

D.V-VI, 1/7-8 ; A.I/9-10 ; V.I/5 ; P. 12-13 ; C. 17 ; L. Lat. 33-34 ; L. Tr. 6.



TEXT FIGURE 1.

Body stout, depth at ventrals $5\frac{1}{4}$-$5\frac{3}{4}$ in length from snout to hypural ; head 4 in the same. Snout $1\frac{1}{3}$-$1\frac{1}{2}$ in the eye, which is $2\frac{1}{2}$-$2\frac{2}{3}$ in the head, and equal to or wider than the interorbital space. Maxillary not expanded posteriorly, reaching to below the margin or anterior fourth of the eye. Teeth minute, slender, acute, apparently arranged in two series in the upper jaw and one in the lower : confined to the front and anterior parts of the sides of the jaws. Vomer, palatines and tongue toothless. Gill-rakers long and slender.

Scales much larger anteriorly than on the caudal peduncle, in 33-34 series between the base of the pectoral and the hypural. There are six between the median series before the second dorsal and the anal, 10-12 between the first dorsal and the head, and nine between the first spines of the two dorsal fins.

Origin of the first dorsal almost midway between the snout and the hypural, and a little behind the vertical of the vent which is between the middle or hinder third of the ventrals. Ventrals inserted about halfway between the pectoral and the dorsal or nearer the latter, and beneath the hinder third or fourth of the pectoral. Anal commencing well, and terminating slightly in advance of the second dorsal.

Colourless after long preservation in alcohol, with a broad silver lateral band. Cheeks and opercles silver. Upper parts with scattered minute black specks.

Described from six specimens, 28-35 mm. long from the snout to the hypural. Through the kindness of Dr. Hamlyn-Harris, Director of the Queensland Museum, I have been able to examine four from Cape York, including the type specimen, while two co-types are in the Australian Museum. The largest of these last is figured. They do not appear to differ generically from *Atherina*, but may be distinguished from most other Australian species by their large scales.

CRATEROCEPHALUS, *gen. nov.*

Freshwater atherines with small protractile mouths, the maxillary not reaching to the anterior margin of the eye. Body covered with large, cycloid, concentrically striated scales which extend forwards on to the upper part of the head: some large scales on the cheeks and opercular bones. First dorsal with about 5-8 spines, the second with I spine and 7-8 rays. Anal similar to dorsal. Microscopic teeth in each jaw; vomer, palatines and tongue toothless, the skin covering the roof of the mouth often bears minute papillae which closely resemble teeth. Gill-rakers short and few, about ten on lower limb of first arch.

Type.—*C. fluviatilis*, sp. nov. *Atherinichthys maculatus*, Macleay, also belongs to this genus.

This genus differs from *Atherina* in having a smaller mouth and shorter and fewer gill-rakers. From *Tœniomembras* it is distinguished by the absence of vomerine teeth.

Atherininichthys, Bleeker, in which *C. maculatus* and other Australian atherines have been placed, is synonymous with *Chirostoma*, Swainson* (type *Atherina humboldtiana*, Cuv. & Val.), and differs from all the Australian species in its small scales, long anal fin, and general form.

CRATEROCEPHALUS FLUVIATILIS, *sp. nov.*

(Plate I.; Figure 1.)

D.V-VII, I/7-8; A.I/8-9; V.I/5; P. 12-13; C. 17; L. Lat. 31-33.

Head $3\frac{2}{3}$-$3\frac{3}{4}$ in the length from the snout to the hypural. Depth $1\frac{1}{3}$-$1\frac{1}{2}$ in the head. Eye longer than the snout, about 3 in the head, and equal to or longer than the depth of the caudal peduncle. Interorbital width a little narrower than the eye in young specimens, wider in adults. Cheeks with a single series of large angular scales, and there are similar scales on all the opercular bones; upper surface of the head with larger irregular scales extending forwards to between the eyes, snout and preorbital naked. Anterior nostril near the margin of the preorbital on the angle formed between the top and side of the snout; posterior nostril near the eye. A line of pores extends from the snout to behind the eye, then bends downwards to a groove above the operculum; another line extends around the preoperculum and branches behind the angle of the mouth, one branch running along the preorbital and the other on to the lower jaw. Maxillary slightly expanded posteriorly not reaching the anterior margin of the eye. Six branchiostegals. Teeth minute, in a single series in each jaw.

Scales large, cycloid, concentrically striated, 31-33 in a row from behind the base of the pectoral to the hypural. Most of those on the dark lateral band are pierced by a simple pore. Between the median scale before the second dorsal and that in front of the anal there are 7-10 rows; in 20 specimens from the junction of the Namoi and Barwon

*See Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, Pt. I., 1896, p. 792, and Pt. IV., 1900, pl. cxxiii., fig. 334.

Rivers there are 7 rows, and in six from Narrandera three have 10 rows, two have 8, and one has 7. The scales extend on to the base of the caudal.

Origin of first dorsal slightly in advance of the middle of the length to the hypural, and a little behind the vertical of the ventrals ; second and third spines longest. Anterior rays of second dorsal longest, the fin originating a little farther back than the anal, to which it is similar in form. Ventrals usually reaching to the vent, sometimes shorter. Upper pectoral rays longest, reaching to the vertical of either the ventrals or the first dorsal.

Colour.—Whitish in formalin with a dark (silver) band extending from above the base of the pectoral to the hypural which may be continued, more or less indefinitely, on to the upper portion of the operculum and side of the snout. Upper portion of head and back with more or less numerous minute black specks which, when present, are arranged near the margins of the scales above the lateral band. Lower parts of the body with a few scattered specks, and a median row on the under surface of the caudal peduncle.

Described from six specimens, 35-61 mm. long, from North Yanko Creek, Narrandera, N. S. Wales, and twenty from a lagoon at the junction of the Namoi and Barwon Rivers, N. S. Wales. The specimen selected as the type is 61 mm. long, from the former locality. They were collected by Mr. David G. Stead, who presented them to the Australian Museum. Other specimens are in the Museum collection from the McIntyre River, on the boundary between N. S. Wales and Queensland.

This species is very probably identical with *Atherina interioris*, Zietz,* from the overflow of Coward and Strangways Springs, Central Australia, which though named, has not been described. Through the kindness of Professor E. C. Stirling, Director of the South Australian Museum, I have been able to examine one of Mr. Zietz's original specimens, but its condition is too bad to enable me to say whether it is identical with those described above or not.

The following notes on the distribution and habits of *C. fluviatilis* have been supplied by Mr. Stead. " The

*Zietz, Trans. Roy. Soc. S. Austr., xxxIII., 1909, p. 264.

Freshwater Hardyhead," which, curiously enough, considering its abundance, has, apparently, hitherto escaped description, is one of the commonest fishes in the Western waters of New South Wales—I may go farther than that, and say throughout the whole of the Murray River Drainage Area. I have collected it from billabongs and lagoons on the Murray River and have seen it in the Mitta Mitta, and other Victorian feeders of the Murray. It has also been sent to me in a collection from the lower Murray in South Australia. I have taken it in the warrumbools and small waterholes of the country north of the Upper Barwon, not far from the Queensland border, and have taken or observed it in Lake Narran, in several places on the Barwon and the Darling (old Collymungool Station, Collarenebri, Calmundi Station, Walget, Barooma, Brewarrina, and Bourke), in Tarrion Creek and the Dry Bogan, in the Bogan proper (at Nyngan), the Macquarie, the Cudgegong (at Rawden and above at an altitude of about 2,500 feet), the Lachlan, the Murrumbidgee (at several places on the plains and also in the vicinity of Cooma at an altitude of about 2,500 feet), Yanko Creek, Edward's, or Kyalite River and the Wakool.

"I have found it equally abundant in such widely-separated places and at such varying altitudes as Mungabarina, near Albury, Rawden near Rylstone, and the Upper Barwon. It may be mentioned that in one haul of the net, at a small waterhole near the junction of the Namoi and the Barwon, I took several thousands of this species from $\frac{3}{4}$-3 inches in length, with a net only 30 feet long by 4 feet deep. In the flowing rivers and larger lagoons it is found principally in the shallows along the banks, and in the clearer waters is seen moving in small schools.

"Adults commonly attain a length of two or three inches, and exceptionally four inches. The spawning season is during the warmer months, and the egg, which is an adhesive demersal one, is relatively large. It subsists upon the small aquatic insects and crustaceans which occur in prodigious numbers in most of the waters of the Murray Drainage Area."

CRATEROCEPHALUS MACULATUS, *Macleay.*

(Plate I.; Fig. 2.)

Atherinichthys maculatus, Macleay, Proc. Linn. Soc. N. S. Wales, VIII., 1883, p. 207, and IX., 1884, p. 40.

D.VI-VIII, I/6-8; A.I/8-9; V.I/5; P. 11-13; C. 17; L. Lat. 32-33.

Head $3\frac{2}{3}$-$4\frac{1}{4}$ in the length from the snout to the hypural. Depth of body $1\frac{1}{4}$-$1\frac{1}{2}$ in the head. Eye longer than the snout, larger than in *C. fluviatilis*, $2\frac{1}{2}$-$3\frac{1}{4}$ in the head, its length equal to or less than the depth of the caudal peduncle. Interorbital as wide as the eye in young specimens, half as wide again in adults. Head scales, nostrils, and pores as in *fluviatilis*. Teeth minute, in three or four rows in the upper jaw, and one or two below.

Scales and fins similar to *fluviatilis*, but the relative positions and sizes of the latter vary somewhat in both species; the ventrals appear to be usually larger in *C. maculatus*. In all my specimens there are seven transverse rows of scales between the median dorsal and anal series in front of the second dorsal and anal fins.

Colour.—Whitish in alcohol with a dark band from the hypural to the pectoral, which is usually also distinct on the head. Upper part of head and back more or less densely speckled with black, and in well-marked examples each scale on the sides bears a central dark spot.

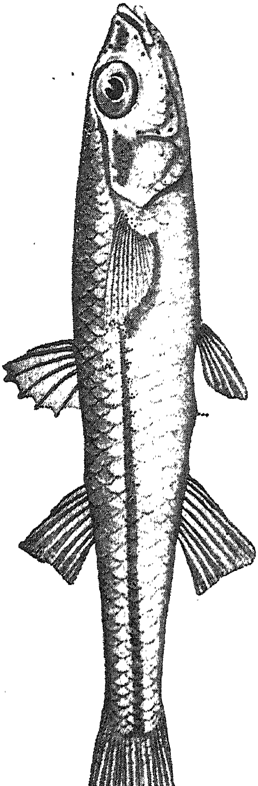
This species was originally obtained in Lillesmere Lagoon on the lower Burdekin River, Queensland. I am unable to find the type specimens in the Macleay Museum, and as they are not in the Australian Museum they are probably lost. The Australian Museum collection includes two specimens from freshwater at Cairns, and two from Townsville, collected by Mr. W. Butcher; four from Eidsvold, Burnett River, collected by Dr. Thomas L. Bancroft; one from near Brisbane, collected by Mr. F. Phillips. Length, 34-74 mm.

C. maculatus is distinguished from *C. fluviatilis* chiefly by its different colour-marking and in having several rows of teeth in the jaws instead of only one. The eye is also larger.

Explanation of Plate I.

Figure 1. *Craterocephalus fluviatilis, sp. nov.* Type, twice natural size.

Figure 2. *Craterocephalus maculatus*, Macleay. Twice natural size.



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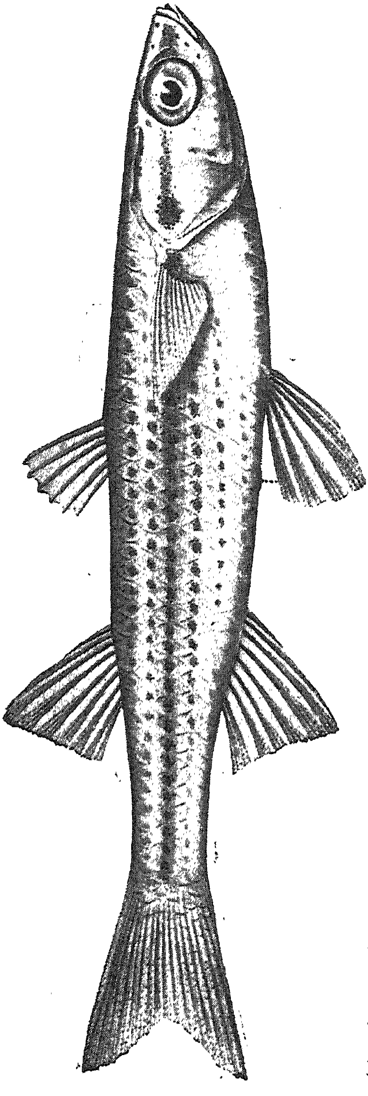


2.

ADDITIONS TO THE MARINE MOLLUSCA OF QUEENSLAND.

PART II.

By JOHN SHIRLEY, D.Sc.

SENIOR INSPECTOR OF SCHOOLS.

(*Read before the Royal Society of Queensland*, 31*st July*, 1912.

In continuation of my paper of September 24th, 1910, in which 348 species, not yet recorded from Queensland, were reported, and which formed a suplement to Mr. Charles Hedley's list of 1911 Queensland species, catalogued in the Proc. Aust. Assoc., Vol. xii., pp. 343-371, and 809-810, I submit a further list of marine shells from this State, not hitherto known to be found on our shores.

Arca (*Scapharca*) *chalcanthum*, Reeve, Normanton.
Arca nivea, Gmelin, Moreton Bay.
Arca reticulata, Sby., Moreton Bay.
Glycimeris angulatus, Lamk., Murray Island.
Modiola Senhausii, Reeve, Murray Island, Normanton.
Crassatellites pulchra, Reeve, Caloundra,
Cardium vertebratum, Jonas, Moreton Bay.
Dosinia laminata, Reeve, Normanton.
Macrocallista impudica, Chem., Normanton.
Euchelus ampullus, Tate, Caloundra.
Euchelus baccatus, Menke, Murray Island.
Turbo pulcher, Reeve, Murray Island.
Strombus tridentatus, Lamk., Murray Island.
Pterocera pseudoscorpio, Lamk., Normanton.
Cithara novæ-hollandiæ, Reeve, Cape York.
Cymatium obscurum, A. Ad., Torres Straits.
Bursa leucostoma, Lamk., Yeppoon.
Cassis strigata, Gmel., Moreton Bay.
Terebra aciculina, Lamk., Murray Island.

Terebra cingulifera, Lamk., Murray Island.
Conus betulinus, L., Torres Straits.
Conus maldivus, Hwass, Murray Island.
Harpa crassa, Morch, Normanton.
Glyphostoma rubida, Hinds, Cape York.
Peristernia nassatula, Lamk., Thursday Island.
Cantharus (Tritonidea) australis, Pease, Murray Island.
Cantharus (Tritonidea) rubiginosa, Reeve, Normanton.
Arcularia compacta, Angas, Bowen.
Thais armigera, Reeve, Torres Straits.
Drupa concatenata, Blain., Thursday Island.

The following are errata in my previous paper of September 24th, 1910 :—

p. 147, line 13, for "*philippinensis*, Desh," read "*Reeveanum*, Dunker."

p. 148, line 30, delete "*Gibbula magus*, L.," which though sent down from Torres Straits is undoubtedly European.

p. 148, line 37, for "*mysticus*, Pilsbry," read "*ampullus*, Tate."

p. 153, line 10, for "*adusta*, Lamark," read "*digitalis*, Reeve."

p. 153, line 15, for "*Hainillei*, Pet.," read "*variabilis* Reeve."

CRATER NEAR HERBERTON.

By R. C. RINGROSE, M.A.

(*Read before the Royal Society of Queensland, 24th April*, 1912)

THIS remarkable spot is situated on the Upper Barron River Watershed, about nine miles from Herberton, and about twelve miles from Atherton, in an area of land comprising two square miles, reserved at the instance of the Herberton Chamber of Commerce as a Reserve for a National Park. The corrected height of the Crater tip above sea level is 3,341 feet, and of the high ridge outside the scrub is 3,566 feet. The bed of the Barron River (Dinner Creek) encircling the Crater on two sides is 3,101 feet. These readings are the result or a series of observations with two aneroids, and corrected by Mr. C. E. Deshon, chief surveyor to the Hydraulic Engineer's Department of Queensland.

The whole of this dividing ridge between the Barron River and Nigger Creek is either too heavily grassed or clothed with dense scrub and the vegetable mould formed by the decomposition of the leaves, to admit of accurate observation of the rocks buried beneath. Speaking generally, the whole of this divide consists of quartz porphyries (composed of felspars and quartz with a small quantity of mica) cut through in places by elvan dykes. A large portion of the high mountain on which the Barron River and Poona Creek rises is largely composed of massive porphyry. The main mass of this range is often cut into intrusive dykes of a fine grained porphyry known as elvans. It may here be noted that the main quartz porphyries and granites of the valleys of the Wild and Walsh Rivers as well as many of the Permo-carboniferous or Devonian series of these valleys are everywhere cut into by a series of intrusive elvan dykes, in some places forming dykes cutting through the ridges at their highest points or occurring in the form of irregular compact masses.

These dykes are probably newer, though possibly of the same period as the huge massive porphyry, which extends from the Valley of the Dry River, some 3½ miles southerly, from Watsonville and crosses the Wild River some seven miles from Herberton and extends past Evelyn Station to the Gorge Road and to the Millstream.

In his report on "The Tin Mines of Watsonville," (1897), Mr. S. J. B. Skertchly, referring to the igneous rocks of the Herberton and Watsonville Districts, says—"The granites are the oldest of the rocks and they are newer than the permo-carboniferous (?Devonian) sedimentary strata for they can be seen forcing their way into these rocks and sending strings and dykes into them, and this is even more marked in the southern part of our Colony than in the northern."

"Next in geological sequence is the great porphyry series which has pushed its way through the granite and sent numerous dykes into it. Following this is the period of the elvan dykes, which intersect alike the sedimentary rocks, the granite and the porphyry. Connected with these elvan dykes is the production of some of the tin-bearing matter, as is abundantly shown in the sequel. Next in order are the basic dykes (diorites, etc.) with which the chief outpouring of the tin occurred."

Last of all, there are the great basaltic outpourings of the Tertiary period similar to so many other districts in Australia.

These main characteristics are well illustrated on the main spur of the Hugh Nelson Range, on which the "Crater" is situated. Descending from the high granite point, from which the view of Bartle Frere and Bellenden Ker is obtained, it is necessary to proceed on foot through the scrub. Here and there cedar trees are met with, and except in a few places the rock is buried under the rich vegetable mould of the scrub. But the main characteristics above referred to are well illustrated, where fragments of the rock are obtainable. Entering the scrub, the rock is here elvan, further on the quartz porphyries appear, and in the bed of the creek, about three quarters of a mile in the scrub, hard elvan porphyry is exposed. Crossing the Creek chocolate soil overlies the rock beneath. Ascending the high ridge forming the Gorge of the Barron River

the quartz porphyries are again visible and extend to the "Crater." The ridge near the "Crater" is narrow, and towards the Barron River Gorge is exceedingly steep. From the summit of the ridge one descends rapidly amongst cedar trees, until one descends almost unconsciously into the great chasm known as the "Crater," hidden amongst the trees at the end of the leading spur, and encircled on two sides by the Barron Gorge. I estimate the distance across the "Crater" at its widest point to be 3½ chains.

From the rim on the low but accessible side, the distance to the water is rather less than 300 feet. On all sides, except where there is a slight slip, the walls are absolutely vertical. The whole of the bottom of the chasm is water, the depth of which measured by a line with a weight on it, is about 300 feet. (These measurements are subject to correction.) The surface of the water is covered with a weed known as "lemna oligorhiza."

The main material of the precipitous walls of the chasm is quartz porphyry, but on one side there is a small belt of fine-grained elvan porphyry. The height of the "Crater" is 3,341 feet above sea level, and the bed of the Barron River, just above the Crater is 3,101 feet. It therefore follows that there is no outlet for the water in the Barron River. As far as is known the level of the water is stationary, and there is no evidence that it either increases or diminishes otherwise than by rainfall or by natural evaporation respectively. The bed of the Barron River is solid quartz porphyry, and from Dinner Creek descends rapidly in a series of pretty cascades, until it passes through a gorge just above Clarke's track to the Russell. Attempts have been made, but no one has succeeded in getting the depth of the water in the centre of the chasm. On the eastern side of the Barron River, Gum Tree Hill rises abruptly out of the river.

What is the origin of this remarkable chasm? What is its age? It has none of the appearances of the volcanoes of the Tertiary basalts. It is newer than the quartz porphyries, and newer than the elvan porphyries. Being carved out of solid rock on the main back-bone of Australia, no other conclusion can be arrived at than that its origin was due to some violent volcanic action of deep-seated origin. There is no evidence of any falling in or

denudation of the rock. There is no rock such as limestone, soluable enough to account for the erosion of such a chasm. There is no evidence that the waters of the Barron River are affected by or swallowed up even to the slightest degree by the Crater. No similar vent or chasm is known to exist in any other portion of the district. It is totally different to Lake Eacham, which is clearly the ruined volcano of the Tertiary period. But the Crater might have been caused by the outburst of a period of volcanic activity, subsequent to the period of the "massive porphyries," and subsequent to the period of the elvan outbursts. The only appearance which lends a clue to the origin of the Crater is, that on the north-west side and highest side rounded stones of exceedingly porous and vesicular basalt are found. Altered zeolite crystals are embedded in all of the boulders.

On the eastern side of the Crater and right down to the edges of the rocky bed of the Barron River itself, there are in places small fragments of basaltic rock, and in other places up the river a few hundred yards, there is abundance of red chocolate soil. Now whether these apparently rounded, highly vesicular fragments of basalt have been ejected with great force up the vent of the Crater, it is impossible to say at present, until something further is known of the country further up the Barron River. This is a pathless jungle at present, and it will be probably many years before the country up the Barron River will be sufficiently opened up to speak with certainty. The writer has not observed such highly vesicular basalt in any other part of the district. Not far away, on the Western edge of the Hugh Nelson Range, the solid basalts of the later Tertiary period have flowed down from some old volcano near the head of the Beatrice, very much along the course of the south branch of Nigger Creek, and finally spread out over the bed of the old bed of the Wild River, and have formed what is now known as the Herberton Deep Lead. The river beds were then wider than they are to-day, and probably the ranges were higher and the rainfall greater. The basalts of these old lava flows are hard, compact basalts for the most part, and have no analogy with the vesicular basalts of the Crater.

There is nothing extraordinary in finding a volcanic vent carved out of rock of a much older series. But it is not usual to find them in a condition much the same as when they were in their original state of activity, and unfilled by rock originally being rising columns of lava, or by falling debris and rocks, either hurled up the chimney itself and falling back into it, or from surrounding rocks shattered from explosions of steam and gases. There is no great quantity of debris found immediately round the Crater near Herberton. Denudation, no doubt, has worn away some of the volcanic deposits. But it is likely enough that volcanic ashes were ejected in large quantities with great force over a wide area. That the early flows of basalt broke through the underlying deep-seated rocks with great force is illustrated by the fact that a dyke of basalt, having no visible connections, has been exposed in solid porphyry country rock in one of the cuttings of the Herberton-Evelyn line near the great Northern Gully, in the town of Herberton, showing that the dykes burst through the most solid country rocks apparently from great depths. This is the only known instance of an isolated basalt dyke unconnected with ordinary basaltic outpourings, and evidently of the most deep-seated origin.

The conclusions to be drawn from the observed facts of the Crater may be :—

1. That the Crater is a volcanic vent, which is newer than the massive porphyries, and newer than the elvan series, and that all the facts point to its origin being caused by a violent manifestation of volcanic activity.

2. Its origin may be older than the period of the Tertiary Volcanic system.

3. It must have been a vent for steam gases and volcanic ejecta between the periods of the massive porphyries, elvan period and the Tertiary volcanic period, and it is conceivable that in some early portion of the Tertiary period. it was an outlet for volcanic bombs of the basaltic type, but it has no connection with and may have been closed up before the period of Lake Eacham and other Tertiary volcanoes.

NOTES ON SOME ENTOZOA.

By T. HARVEY JOHNSTON. M.A., D.Sc.
(Biology Dept., University, Brisbane).

(Plates II, III, IV, V).

Read before the Royal Society of Queensland, 26th June, 1912.

Ophiotænia hylæ, n. sp.
(Pl. II ; Figs. 1, 2).

Host :—*Hyla aurea* ; specimens collected by Dr. S. J. Johnston, of Sydney University, from frogs captured in the neighbourhood of Sydney.

Length, over 6 cm. ; greatest breadth, about ·75mm.

The scolex is a rounded unarmed structure, ·32 mm. in width, with four suckers, each about ·11 mm. in diameter, and a rudimentary apical sucker or muscle plug. There may be a slight neck-like constriction, succeeded by a relatively long unsegmented region of about the same breadth as the scolex. Segmentation is of the usual type seen in the Proteocephalidæ. The proglottids do not project aterally, nor do they vary much in width after sexual maturity has been reached. The genital pores are situated at about the middle of the segments and alternate irregularly.

The muscular, nervous and excretory systems are of the general Proteocephalid type. The testes consist of numerous vesicles of about ·03 mm. diameter, arranged dorsally in two wide lateral fields between which lies the uterus. These fields extend almost from the anterior border of the segment to the ovary. The vas deferens may be recognised as a coiled tube in the middle of the proglottis, lying above the uterus and passing laterally n close coils above and parallel to the vagina until it enters the cirrus sac within which the vas becomes thrown into

a few rather wider convolutions. The greater part of the sac is occupied by the wide eversible unarmed cirrus which is capable of being everted to a length of ·20 mm., its width in such a state being about ·033 mm. The cirrus sac, when the cirrus is at rest, is a pyriform organ ·14 mm. long and about ·055 mm. wide in its inner portion. The male pore lies postero-dorsally to the female aperture, both terminating in a very short genital cloaca.

The large bilobed ovary consists of numerous tubes whose terminations lie dorsally, the ovarian bridge being ventral. Its duct is short. Situated dorso-laterally in the cortex in the region of the longitudinal nerve are the vitelline follicles, each with a diameter of about ·013 mm.

The vagina is a wide tube lying antero-ventrally to the cirrus sac, narrowing somewhat as it passes inwards below it and the vas deferens to bend backwards and travel above the uterus. Just in front of and above the ovary, there is a slight enlargement, the receptaculum seminis, followed by a narrowed portion or fertilising duct into which the oviduct enters. The shell gland lies in this region. The uterus arises as a thin duct which passes forwards ventrally, along the mid-line, below the ovary and the vagina. Numerous short lateral diverticula appear at an early stage, and as egg-formation proceeds, these become much more prominent, until at length the uterus appears as a much-branched structure almost filling the medulla. The eggs measure from 15 to 19 micra in diameter, and the oncospheres from 7·5 to 11 micra. Vitellaria persist even in segments with fully formed embryos.

Ophiotænia hylæ appears to be the first adult cestode described from an Australian amphibian.

La Rue (1911, p. 473), has recently subdivided the genus *Proteocephalus*, one of the genera being *Ophiotænia*, to which our form belongs. The differences between *Acanthotænia* and *Ophiotænia* are very slight. The latter might even be regarded as a subgenus of the former.

Acanthotænia gallardi, Johnston.

(Pl. II; Figs. 3, 4).

This cestode was described by me last year (1911*a*, p. 175), under the name *Proteocephalus gallardi*, mention being made (p. 181) that it belonged to the subgenus

Acanthotænia. La Rue (1911) has recently dealt with the Proteocephalidæ, and has restored Linstow's name (Johnston, 1909, pp. 112, 114) to full generic rank. He includes all the known Proteocephalids from amphibia and snakes under *Ophiotænia*, a genus whose members do not possess the tiny cuticular spines which occur on the anterior end of species of *Acanthotænia*. Our form which infests several species of Australian venemous snakes, is, however, a typical *Acanthotænia*. It was originally described from *Pseudechis porphyriacus* and very shortly afterwards (Johnston, 1911*b*, p. 239) was recorded from the tiger snake, *Notechis scutatus*, mention being made that a closely allied species parasitised two other snakes, *Denisonia superba* (p. 239) and *Pseudechis australis*. A careful comparison has led me to consider that all four snakes harbour the same species of cestode. The main difference seen is in regard to the number and shape of the testes, but the former is variable, while the elongate form of the glands as seen in specimens from the two last named snakes, is apparently due to imperfect preservations, both series of specimens having been taken by me from the intestine of reptiles which had been preserved for some time in alcohol. The arrangement of all the organs as seen in transverse sections, agrees entirely with that already figured (1911*a*, pl. vii., figs. 2, 3.)

Acanthotænia tidswelli, Johnston.

Specimens of this tapeworm which is known to occur in *Varanus varius* (Johnston, 1909, p. 103), and in *V. gouldii* (1911*b*, p. 242), have been collected from Bell's monitor *V. bellii*, forwarded by Dr. T. L. Bancroft, from Eidsvold, Burnett River. This reptile harboured in its stomach several nematodes, *Physaloptera varani* ?, similar to those already recorded from the two above-named lizards, while in its blood there were present hæmogregarines, *Hæmogregarina varanicola*.

Some authorities regard *V. bellii* as being only a well-marked variety of *V. varius*.

Hymenolepis diminuta (Rud.)

From rats, thus *decumanus* and *M. rattus* (*Alexandrinus*) caught in Brisbane. Not previously recorded from Queensland.

Hymenolepis carioca (Magalh.)

From a domestic fowl, Brisbane. Not previously reported from Queensland.

Hymenolepis megalops (Nitzsch).

This species has been identified from material collected from a Black Duck, forwarded by Dr. Bancroft, Eidsvold and is now definitely recorded from this State.

A new host for this parasite is the Teal, *Nettion castaneum*, specimens having been collected by Mr. C. J. Woollett near Cobar, N.S. Wales.

The parasite under review was described by Krefft (1873, p. 220; Johnston, 1912, p. 33) as *Tænia cylindrica*, and is quite a different form to that described under the same name by Clerc (1902, p. 661), whose specimens came from a gull *Larus canus*. Clerc's species has been listed as *Dilepis* ? *cylindrica* and *Choanotænia* ? *cylindrica*, but since the specific name was already preoccupied in *Tænia*, the name *clerci* might be substituted for it. (*Tænia clerci*=*Choanotænia* ? *clerci*, nom. nov.)

Diorchis flavescens (Krefft).

Found by me in a Black Duck, *Anas superciliosa*, shot on the Burnett River. In company with this species of cestode were some trematodes, *Echinostoma* sp. (*sensu lato*).

Amœbotænia cuneata (Linstow).

Found in some fowls in Sydney and also in Brisbane. This small parasite had not been recorded as occurring in Australia.

Bancroftiella glandularis (Fuhrmann).

This cestode was originally described by Fuhrmann under the name of *Anomotænia glandularis*, from *Herodias timoriensis*, his material being collected in the East Indies. It is now recorded as infesting the Blue Crane, *Notophoyx novæ-hollandiæ*, my specimens being collected by Dr. S. J. Johnston near Gosford, N.S. Wales. I have the same species from this host from Queensland.

It belongs to the genus *Bancroftiella* (Johnston, 1911c, p. 50).

Tænia crassicollis, Rud.

Found in a local cat (Brisbane). Not previously recorded from Queensland.

Cysticercus fasciolaris, Rud.

This bladderworm stage of *Tænia crassicollis* is fairly commonly met with in the liver of local rats (*Mus decumanus* and *M. alexandrinus*) and mice (*M. musculus*), but its presence in Queensland does not appear to have been reported.

Dipylidium caninum (L.)

A common parasite in local dogs and cats (Brisbane), but apparently unrecorded from this State.

Diploposthe lævis, Bloch.

This large and interesting cestode has again been met with in a White-eyed Duck, *Aythya australis*, kindly forwarded by Dr. Bancroft from Eidsvold. It is now definitely recorded from Queensland. Krefft, who described the parasite as *Tænia tuberculata*, did not refer to a definite locality, mentioning merely that his material was collected in either New South Wales or Queensland.

Metroliasthes lucida, Ransom.

Found in the domestic turkey, my specimens being collected in Sydney from material supplied by Mr. Thos. Steel, through the Bureau of Microbiology, Sydney. This identification constitutes the first record of the occurrence of the species in Australia.

Davainea cesticillus, Molin.

Has been identified from a local fowl (Brisbane). Not previously recorded from Queensland.

Davainea tetragona, Molin.

Has been found several times in local fowls (Brisbane). This species has been previously recorded by Dr. Sweet (1910, p. 243), as occurring in Rockhampton.

Davainea varians, Sweet.

This tiny parasite of domestic fowls has been described by Dr. G. Sweet (1910, p. 243), but it seems to me to be synonymous with *D. proglottina*, which is admittedly a variable species. The main difference appears to be in the size

and form of the rostellar hooks, but it is often a difficult matter to figure these quite accurately, and the differences are small. The general anatomy is similar to that of *D. proglottina*.

Cittotænia bancrofti, n. sp.

(Pl. V; Figs. 42, 45).

This large cestode parasitises one of the small wallabies, *Onychogale frenata*, specimens having been collected for me by Dr. Bancroft (Burnett River District). The length is about 15 cm. and the maximum breadth 14 mm. The unarmed scolex is large, being 1·9 in diameter, and bears four powerful suckers, each about ·72 mm. in diameter. There is no unsegmented neck region, the strobila consisting of very numerous narrow leaf-like segments, which gradually increase in length and breadth as they pass backwards. The genital papilla lies in the posterior half of each margin.

The longitudinal musculature is very powerful, consisting of a broad zone of bundles lying in the inner portion of the cortex, the outer portion being free from them. The bundles on the outer edge of the zone are smaller than those lying nearer the well-developed transverse muscles. Dorso-ventral fibres are abundant. The dorsal excretory vessel is a small tube situated laterally from the larger ventral canal. The nerve lies just above, or at times dorso-laterally to, the dorsal vessel. The sex canals pass above both the excretory canals and the nerve, the male duct lying above the vagina. Both sex canals terminate in a common genital chamber which communicates with the exterior through the genital pore.

Testes were not distinguishable in the specimens. There is a large cirrus sac in each half of the segment. Its length when the cirrus is at rest, is from ·8 to 1 mm., and the breadth ·019 mm. It possesses relatively thick muscular walls. The vas deferens forms a small closely-coiled mass near the inner end of sac, and after entering the latter, enlarges to form a vesicula seminalis. The cirrus may be everted to a distance of ·30 mm. beyond the genital pore. It then appears as a wide organ (·14 mm. in width), covered with very numerous tiny spines so closely set as to give a stippled appearance.

The female organs are duplicated and are somewhat obliquely placed. The inner and anterior portion of the female complex consists of the ovary, while the more laterally situated posterior division consists of the vitellarium Separating the two is the receptaculum seminis. The vagina travels inwards behind and below the cirrus sac in a slightly sinuous course, becoming widened in its progress, its inner portion being the widest portion. As already mentioned, this receptaculum lies above and anterior to, the yolk gland. Each uterus arises as a transverse tube from which numerous processes or pouches develop anteriorly and posteriorly. The two uteri extend medianly and eventually almost touch. I have not determined whether they ultimately fuse or not.

The above description is of a preliminary nature.

Dibothriocephalus felis, Creplin.

This cestode is met with occasionally in cats. In addition to specimens from Queensland, I have others collected in Melbourne, in Sydney, and near Gosford, New South Wales.

Cysticercoids of *Hymenolepis diminuta* and *H. murina*. (Pl. III; Fig. 11).

During the time that I was associated with the Government Bureau of Microbiology, Sydney, I had opportunity of examining some thousands of rat-fleas, the species represented being almost entirely the three common fleas infesting *Muridæ*, viz., *Xenopsylla cheopis*, *Ceratophyllus fasciatus* and *Ctenopsyllus musculi*. In the last-named species, no parasites were found, while in the two former there were met with occasionally two distinct species of Cysticercoids as well as larval nematodes to be referred to later. Rarely, both the nematodes and one or other species of Cystercoid occurred in the one host, and also rarely, both species of Cysticercoid in the same *Ceratophyllus*.

These cestode larval are identical with those described and figured by Nicoll and Minchin (1910, p. 9; text figs. 1, 2, Minchin, 1909, p. 741), who proved experimentally that they were the Cysticercoid stages of two common rat-parasites, *Hymenolepis diminuta* and *H. murina*. They were found only in *Ceratophyllus fasciatus* and in about

four per cent. of specimens examined. The former larva is pyriform, with an unarmed scolex and a fairly long tail, while the Cysticercoid of *H. murina* is rather broader and shorter, has scolex armed with small hooks and possesses a short thick tail.

Xenopsylla cheopis is thus a new host for these two larval forms, and the known geographical distribution is extended from Europe to Australia. As mentioned by Nicoll and Minchin, there is usually only one larva present at a time, but I have met with multiple infection. On one occasion there were found no less than *nine* Cysticercoids of *H. murina* (see Fig. 11) in a *Ceratophyllus fasciatus* taken from *Mas decumanus* in Sydney (1909) ; on another occasion three larvæ belonging to the same species were found in a *Xenopsylla cheopis* taken from *Mus rattus*, also in Sydney. One specimen, a *H. diminuta* Cysticercoid, was found in one flea, *C. fasciatus*, out of six sent to me in 1910 from Melbourne for identification.

The presence of these parasites was detected in specimens of fleas after clearing the latter and mounting them in long series in canada balsam.

A record of the per centage infection was kept, but it has been mislaid. It was, I believe, about the same as that already recorded.

Sparganum, sp.

(Pl. II ; Figs. 5, 6).

Cestode larvæ (plerocercoids) occur occasionally in certain parts of the body, mainly in the thigh muscles, of some Australian frogs, *e.g.*, *Hyla aurea* and *H. cærulea.* I have examined specimens from the former host from Perth, West Australia, collected by Dr. J. B. Cleland, and from Sydney, N.S. Wales, collected by Dr. S. J. Johnston, and by myself ; and also from the latter host from Sydney, and from the Burnett River, Queensland, collected by Dr. Bancroft. The figures have been drawn from a specimen mounted by Dr. S. J. Johnston.

The parasite has already been described by Professor Haswell (1890, p. 661), its occurrence in various localities having been noted by myself (1911*b*, p. 234) Prof. J. P. Hill (1905, p. 369) also has referred to it. The general

appearance of the anterior end is shown in Fig. 5. The width is fairly uniform (·7 mm.) throughout the greater part of its length, the broadest portion being anterior (1·4 mm.) The length varies somewhat, some of the complete specimens examined measuring 47 mm. The posterior end is rounded (Fig. 6), and bears the excretory pore lying at the base of a small depression. The body is imperfectly ringed, and the cuticle is also thrown into small folds.

Calcareous corpuscles are abundant. The longitudinal muscles are arranged in a series of well-marked bundles. The excretory canals lie deeply, each being distant from the margin about a third of the body diameter. They join near the posterior end to form a very short common tube terminating at the excretory pore. The nervous system consists of a small mass just behind the slit-like depression at the anterior end, and of a pair of prominent laterally situated strands, as well as a pair of longitudinal nerves.

Fasciola hepatica, L.

Specimens of the common liver fluke were forwarded from Ipswich, having been taken from sheep and cattle.

Heterakis chenonettæ, n. sp.

(Pl. IV; Figs. 31, 33).

Last year, I took from the cæcum of a wood duck *Chenonetta jubata*, near Sydney, a number of specimens of a small *Heterakis*, which appear to belong to a new species. The dimensions are:—Male—length, 6.8 mm.; breadth, ·19 mm.; female—length, 7·7 mm.; breadth, ·26 mm. This species is thus slightly longer than *H. bancrofti*.

The cuticle bears very fine annulations. The anterior end tapers rather rapidly from region of the nerve ring, while the posterior portion of the worm becomes gradually narrowed to terminate in small fine tail. The lips are equal in size, but are small. The excretory pore lies at ·422 mm. from the head end, in the same region as the nerve ring. The vulva is situated just behind the middle of the body (4·2 mm. behind the head). The anus in the female lies at .53 mm. from the posterior end.

The tail of the male terminates in a fine point. The alæ are prominent and bear nine pair of papillæ, whose position is indicated in Fig. 30. Four pair are pre-anal

three pair lying just in front of and laterally to the prominent cloaca, while one pair lies laterally from the sucker of the post-anal papillæ; three pair are almost caudal in position. The sucker is situated at a considerable distance (·194 mm.) in front of the cloaca, and appears as a prominent organ. The spicules are 1·17 mm. in length, and ·013 mm. in breadth. The longer male spicule is strongly curved, and has a fairly uniform breadth (·008 mm.), but tapers slightly towards the extremity. The length is ·48 mm. The shorter spicule has a length of .18 mm., and a breadth (in its midregion) of ·012 mm., but the extremity is widened and rounded.

The uterus contains eggs with vermiform embryos.

Heterakis bancrofti, n. sp.

(Pl. IV; Figs. 28, 30).

The cæcum of the brush turkey, *Catheturus lathami*, is commonly infested by small nematodes, which at first sight remind one of *Heterakis papillosa* of the fowl. Dr. Bancroft has forwarded me material from the Burnett River district, while Mr. R. Dart has sent me material from Laidley. From all of the specimens, this species of nematode has been taken. It is therefore a common parasite of this host. Occasionally one finds in company with it a much larger *Heterakis*, described below as *H. catheturinus*, as well as a *Tænia*-like species of *Echinorynchus*, or, perhaps more correctly, *Gigantorhynchus*.

Heterakis bancrofti has the following dimensions:—male—4.3 mm. long and ·22 mm. broad; female 6·25 mm. long, and ·33 mm. broad. The anterior end tapers gradually while the tail of the female is rather short and sharply-pointed, that of the male being very narrow and delicate (Fig. 30). The vulva is situated at about the middle of the body, the excretory pore at ·260-·265 mm. from the anterior end, and the anus (in the female) at ·91 mm. from the posterior extremity.

There are three prominent lips of equal size, with deep notches between them. The alimentary canal is of the usual *Heterakis* type. The nerve ring surrounds the pharynx at ·16 mm. from the anterior end, and is situated just in front of the excretory pore.

The male spicules are equal and relatively long (·860 mm.), sharp-pointed structures, the points being turned backwardly. Their form is indicated in Fig. 30. The sucker is chitinised and possesses a diameter of ·073 mm. Its posterior margin is situated at about ·035 mm. in front of the cloaca. Lying between it and the cloaca is a pair of pre-anal papillæ. The disposition of the papillæ around the lobed alæ is indicated in the figure, there being two pair placed pre-anally, two pair post-anally, and two pair just near the junction of the alæ with the narrow pointed tail.

This species is associated with the name of Dr. T. L. Bancroft, who has rendered me considerable service in regard to material.

Heterakis catheturinus, n. sp.

(Pl. III; Figs. 23, 25. Pl. IV; Figs. 26, 27).

As already mentioned, this large species may sometimes be found in company with the commoner species *H. bancrofti*, infesting *Catheturus lathami*. My specimens have been collected from material forwarded by Dr. T. L. Bancroft from the Burnett River. Adult females may reach a length of 28 mm., males being somewhat shorter and attaining a length of 21 mm.

The anterior end is rounded and narrow, while the posterior extremity terminates in a short pointed tail in both sexes. The three lips are equal in size, their characters being indicated in Fig. 24. The excretory aperture lies at a distance of ·8 mm. behind the mouth. The vulva is situated at about the middle of the body length, on a slight elevation. The anus is distant from the posterior extremity ·40 mm. in the case of the male, and ·86 mm. in the case of the female. At each side of the anterior end of the parasite, there is a ridge or ala, arising laterally just behind the mouth and travelling backwards for about two millimetres. The cuticle bears fine transverse rings.

The alimentary canal is of the usual type, and is surrounded at ·50 mm. behind the mouth by the nerve ring.

The male spicules are slightly curved pointed rods, measuring 1·05 mm. in length, and ·022 mm. in width. The male tail is not prominent, the alæ being narrow. The sucker lies at some distance (·275 mm.) in front of the cloaca. There are two pair of prominent pre-anal papillæ, a small unpaired median pre-anal, and a small unpaired post-anal papilla, followed by six paired post-anal papillæ, the arrangement of these sensory structures being indicated in the figure of the tail end of the male. (Fig. 25).

Heterakis papillosa, Rud.

A common parasite of poultry (Brisbane), but hitherto unrecorded from this State.

Heterakis perspicillum, Rud.

More commonly known as *H. inflexa*. A fairly common but apparently unrecorded nematode infesting local fowls (Brisbane).

Heterakis spumosa, Schneider.

Present in *Mus decumanus* and *M. rattus* (Brisbane). Not previously recorded.

Belascaris mystax, Rud.

Formerly grouped with an allied round-worm parasitic in the dog, under the name of *Ascaris canis*. This species was found in a local cat, and has not been recorded as yet from this State.

Toxascaris canis, Gm.

Occurs in local dogs (Brisbane), but is apparently unrecorded until now.

Ascaris spiculigera, Rud.

Numerous specimens were taken by me from the oesophagus and stomach of a cormorant, *Phalacrocorax sulcirostris*, and a darter, *Plotus novæhollandiæ*, shot on the Burnett River, Eidsvold, by Dr. Bancroft. *Ascaris*, sp., recorded by Krefft (1873, p. 213), from the latter host, belongs to the same species.

Some parasites which I have collected near Sydney from the pelican, *Pelecanus conspicillatus*, are referred to the same species. They are rather larger, but appear to be specifically identical with the above.

A larger species of *Ascaris* from the stomach of *Phalacrocorax carbo*, shot by Dr. Cleland on the Hawkesbury River, N.S. Wales, is of the same general appearance, but does not agree entirely with the available accounts of *A. spiculigera*.

Amblyonema terdentatum, Linstow (1898, p. 470).

This species of nematode has been found quite commonly by Dr. Bancroft and myself in the spiral valve of specimens of *Neoceratodus forsteri*, caught in the Burnett River. In company with it, on one occasion, there were found a few specimens of a small *Amphistoma*.

Oxyuris obvelata, Bremser.

Occurs in *Mus decumanus*, *M. rattus* and *M. musculus* in Brisbane. Not previously recorded.

Trichosoma hepaticum, Raill.

Found in the liver of *Mus decumanus*, *M. rattus* (*alexandrinus*), and *M. musculus* in Brisbane. Its presence in Queensland was recorded by Dr. Bancroft (1893*b*, p. 89), who described it from *Mus rattus* as *Trichocephalus hepaticus*. It was originally described by Railliet under the same specific name.

Trichodes crassicauda, Bellingham.

Occurs in the bladder of *Mus decumanus* (Brisbane). Not previously reported from this State.

Spiroptera obtusa, Rud.

From the stomach of *Mus musculus*, *M. alexandrinus* and *M. decumanus* in Brisbane. Apparently unrecorded from this State.

Hystrignathus hystrix (Cobb).

Cobb (1898, p. 315), originally described this species as *Xyo hystrix*, it being the type of his genus *Xyo*. A comparison of Cobb's figure with those given by Leidy (1853, Pl. 7, Figs. 8, 9, 10), leads us to synonymise *Xyo* with Leidy's *Hystrignathus*.

Dr. Cobb did not actually give an account of his form, but defined it by means of his "nematode formula" and a figure. The host is quoted as beetle, *Passalus*, sp. *H. hystrix* is a parasite of the large common passalid beetle, found in rotten timber, and identified for me by Mr. W.

Gurney, of the Entomologist's Branch, Sydney, as *Mastochilus*, sp. It is under this host name that these tiny nematodes should be placed.

My specimens were collected in various parts of New South Wales.

Echinonema cinctum, Linstow.

This roundworm was originally described as *Hoplocephalus cinctus*, by Linstow (1898, p. 469), from material taken in Queensland by Prof. Semon from a bandicoot, *Permaeles obesula*. It is now recorded, from the "native cat," *Dasyurus viverrinus*, my specimen of the parasite—a female—being collected from a dasyure secured by Mr. T. Steel, in a suburb of Sydney.

Filaria websteri, Cobbold.

This large nematode infests the bursa at the knee-joint of several kangaroos and wallabies. I have recently received specimens collected near Eidsvold by Dr. Bancroft from *Macropus giganteus*, *M. dorsalis*, and *M. parryi*.

Habronema muscæ (Carter).

The larval stage of this parasite, *Habronema muscæ*, has been met with in two species of flies, *Stomoxys calcitrans* and *Musca domestica* in Sydney, and in the latter in Brisbane. As far as I know, the larval form has not been previously recorded from Australia.

Ransom (1911, p. 690), has recently shown that *H. muscæ* is the larval stage of a parasite which infests the stomach of the horse.

A larval worm which has the general form and characters of the above species occurs in the head region of the common "cattle fly," found frequenting, especially the eyes of cattle, in Queensland and determined as *Musca vetustissima*. I am indebted to Dr. Bancroft for specimens taken near Eidsvold in the Burnett River district of this State.

Filaria clelandi, n. sp.

(Pl. II; Figs. 7, 8).

A single specimen—a male—was found by Dr. Bancroft in the peritoneum of a magpie, *Gymnorhina tibicen*, shot near Eidsvold. Its length is 27 mm., and its breadth ·62 mm. The cuticle is quite smooth. The ends are

somewhat similar in appearance both being obtusely rounded, but the tail end is broader. At the head end are three papillæ placed laterally, while surrounding the mouth are three very slight pit-like depressions, with each of which is associated a highly refracting rod-like structure, apparently of a chitinoid nature. This bifurcates, each branch being relatively long. These six rods come into relation with the anterior end of the alimentary canal, where it meets the mouth cavity which has thus something of the character of a mouth capsule. The alimentary canal is of the usual filarial type ; the nerve ring surrounding it at a distance of ·027 mm. from the anterior end of the worm. The anus is subterminal, lying at only ·08 mm. from the posterior end.

No definite papillæ were recognised in the colacal region, though there appeared to be indications of a small pre-anal pair. The male spicules are relatively large and thick ; the longer being ·75 mm. in length, sabre-like, twisted and with a broad lancet-like termination ; while the other is also long, but is bent in a remarkable manner to form an elongate S. The total length of the latter, including curves, is ·60 mm. The general breadth of both spicules is the same (·025 mm.)

I desire to associate with this species the name of my friend and former colleague, Dr. J. B. Cleland. We have already described two forms of larval filariæ (Cleland and Johnston, 1910, p. 107), found in the blood of this host in N.S. Wales, but Dr. Bancroft (1889, p. 61), had already recorded the occurrence of larvæ in specimens taken in Queensland. Simultaneously with ourselves, Drs. Gilruth, Sweet and Dodd (1910, p. 236) described several different forms under the name, *Microfilaria gymnorhinæ*. It is inadvisable to confer specific names on larval filarial forms since it is not always an easy matter to associate a larva with the adult form ; hence confusion in nomenclature is more likely. As the specific name given includes more than one form, there need be no hesitation in naming the adult male which has been briefly described above.

Plimmer (1912, p. 138) also mentions finding embryos in this host, his birds having died in the London Zoological Gardens.

Microfilaria sp.

(Pl. III; Figs. 16, 17).

Filarial embryos have been found by Dr. J. B. Cleland and myself in *Plotus novæhollandiæ* and *Phalacrocorax sulcirostris*, both shot on the Burnett River by Dr. Bancroft. These larvæ are relatively long (·163 to ·236 mm.) and narrow (·004 to ·006 mm), with a rounded anterior end and a pointed posterior extremity. A sheath is present.

Filaria sp.

(Pl. III; Figs. 14, 15).

I found several immature female filariæ encysted in the subcutaneous tissues of a "leather-head" *Philemon citreigularis* forwarded by Dr. T. L. Bancroft from Eidsvold They were coiled up within fairly thick brownish cysts, only the head end protruding. Their length, when uncoiled, is 10 mm. The cuticle is very distinctly ringed, the ridges being similar in general appearance to those present in species of *Onchocerca*.

The anterior end is narrowed and bears six papillæ, while the posterior end is pointed. The anus lies at about ·16 mm. from the latter. The nerve ring is situated at about ·14 mm. from the head extremity. The mouth soon leads into the œsophagus which in its turn communicates with the intestine. The excretory pore is situated in the region of the nerve ring.

Filaria, sp.

(Pl. IV; Figs. 37, 38).

A mature female worm, about 20 mm. in length, and ·7 mm. in maximum breadth was taken by Dr. J. B. Cleland from the subcutaneous tissues of a honey-eater, *Acanthogenys rufigularis*, shot near Sydney, N.S. Wales.

The anterior end is narrowed but terminates abruptly, while the posterior extremity ends in a short bluntly-rounded tail. The cuticle is practically smooth. The three lips are not prominent, but each bears a tiny papilla. Lying at a short distance behind the mouth are the excretory aperture (at ·14 mm.), and the female pore (at ·24 mm.) Lateral lines are relatively broad, the excretory vessels travelling within them in a sinuous course. The

alimentary canal is of the usual filarial type, the œsophagus measuring ·64 mm. in length. The anus lies very close to the posterior end, being only ·130 mm. distant. The nerve ring is situated at ·16 mm, from the anterior extremity.

The two uteri which contain eggs with vermiform embryos within them, join to form a very short vagina near whose external opening are gland cells. The eggs *in utero* measure ·050 by ·028 mm.

Filaria physignathi, n. sp.

(Pl. III ; Figs. 18, 22).

The presence of filarial embryos in the blood of *Physignathus lesueurii*, Gray, has already been made known (Johnston and Cleland, 1911, p. 489), while mention has been made (Johnston, 1911*b*, p. 241) of the fact that the adults were found in the mesenteric veins by Dr. Bancroft. These adult worms, mainly females, were forwarded to me and are now dealt with under the name of *Filaria physignathi*. Filarial embryos have been recently recorded as occurring in another Australian lizard, belonging to the same family, *Amphibolurus barbatus*, by Plimmer (1912, p. 139), whose specimens came from the London Zoological Gardens.

The dimensions of the new parasite are as follows :— Male 12 mm. long, and ·20 mm. broad ; female, about 36 mm. long, and ·33 mm. broad.

The following account is taken from a female. The diameter of the body is uniform, each end being bluntly rounded. Three small papillæ appear to be present at the anterior end. Lips are absent. The anus is terminal. The vulva is situated at about 1·40 mm. from the head end, and lies on the summit of a small elevation surrounded by a definite depression. The excretory pore lies in front of the nerve ring, at about ·130 mm. from the anterior extremity. The cuticle is not transversely striated, but is smooth and thin.

There is no mouth cavity or pharynx. The œsophagus is ·82 mm. in length, being surrounded at ·180 mm. from the mouth by the nerve ring. Its front portion is rather wider than the remainder. Succeeding the œsophagus is the widened thin-walled intestine, which terminates at the anus at the end of the worm.

The female glands and ducts are very extensive, coils being present close to the anus, while the common uterus —a wide tube—terminates close to the anterior end, as already mentioned. The lower parts of the female canal are crowded with free embryos of the type already described as occurring in the blood. Surrounding the vulva are numerous vaginal glands. The female aperture is very narrow.

The male is quite small when compared with the female. The tail is spirally rolled. The cloaca lies at ·097 mm. from the blunt posterior end. The nerve ring lies at about ·130 mm. behind the mouth. A coil of the testis approaches quite closely to the region of the nerve ring. The alæ are very small and papillæ are poorly represented. There appears to be a pre-anal pair just antero-laterally to the cloaca, as well as two pair of post-anal papillæ just behind the cloaca. The spicules are rather small, the larger being ·162 mm. long, slightly curved, and bearing a pointed extremity. The smaller is ·081 mm. long, also slightly curved, but its extremity is widened, as often happens in Filariidæ.

The specimens were collected by Dr. Bancroft from the water dragon, *Physignathus lesueurii*, on the Burnett River, near Eidsvold.

Oxyspirura anthochæræ, n. sp.

(Pl. IV; Figs. 34, 36).

As far as I am aware, no nematodes have been described as infesting the eyes of native birds in Australia. Krefft (1873, p. 213), recorded the presence of *Ascaris* sp. from the eye of a gill-bird, *Anthochæra carunculata*. I have already remarked (1910, p. 111), that the worms probably belong to the Filariidæ. An examination of Krefft's specimens, through the courtesy of the Curator of the Australian Museum, Sydney, shows them to belong to that family, and apparently to *Oxyspirura*. In my list of entozoa known to infest Australian birds, I have recorded this form as *Ceratospira anthochæræ* (1912*b*, p. 111). The position of the female pore is posterior instead of anterior, hence the species must be transferred to *Oxyspirura*.

The specimens had become dried up and are therefore of little value. The description given below is lacking in many details, but should allow the recognition of the species in the future.

The length of the male is about 8·5 mm., and of the female 8 to 9 mm. The breadth of each is about ·11 mm. The cuticle is finely striated transversely. The head end has suffered in drying. Neither lips nor papillæ are recognisable on the rounded anterior extrèmity, which is slightly swollen when compared with the succeeding neck region. The posterior end of the female is sharp-pointed, the anus and the genital aperture lying at ·194 mm. and ·32 mm. distant, respectively, from the extremity. The cloaca in the male lies at ·08 mm. from the tail end, which is spirally curved and is shorter than the female tail. No male papillæ were discernible.

A small mouth cavity is present. Surrounding the pharynx at a distance of ·195 mm. from the anterior end, is the nerve ring.

Larval nematodes in fleas.

(Pl. III ; Figs. 12, 13).

As a result of examining a large series of rat fleas, as mentioned earlier, the presence of small coiled nematode larvæ, *Agamonema* sp., was detected in a goodly number of *Xenopsylla cheopis,* and—on only one occasion—*Ceratophyllus fasciatus*, all the parasitised fleas coming from Sydney and district. As far as I am aware, the presence of larval nematodes in fleas, has not been recorded. Usually, there was only one present, but sometimes two, three or four, while on one occasion, no less than six of them were present in the body cavity of a male *X. cheopis* When compared with the size of the host, these larvaæ are quite large as a glance at Fig. 12 will indicate.

In nearly every instance the parasite was closely, usually spirally, coiled and therefore very difficult to examine. Sometimes a relatively thick cyst enclosed it. Owing to their transparency, their presence is not detected unless the bodies of the fleas be either carefully teased up and examined in saline or other solution with a minimum amount of light, or the hosts be cleared and examined, very little light being allowed to pass through them. They

are delicate, practically colourless worms ·43 mm. in length and ·042 mm. in width, which is uniform throughout the greater part of the body. The body bears delicate transverse rings. The posterior end tapers rapidly to become pointed, while the anterior extremity narrows more slowly. The whole larva bears a striking likeness to *Habronema muscæ*. I therefore consider it to be the young form of a *Spiroptera sensu lato*.

The species of *Spiroptera* which infests rats and mice in Australia is *S. obtusa*. It is thus quite likely that the larvæ under review, belong to this species. The probability is suggested by the following facts :—*S. obtusa* is quite common here. Its eggs pass to the exterior with the fæces of the rat or mouse and come to reach the earth in the rat holes, or elsewhere where the rat-flea eggs are developing into larvæ. The latter are known to be able to ingest rat-cestode eggs with contained embryos, *e.g.*, *Hymenolepis diminuta* and *H. murina* which also reach the exterior with the fæces. It is thus not unlikely that the life history of *S. obtusa* is different from that of *Habronema muscæ*, whose eggs become ingested along with organic matter in horse manure by the fly larvæ (*Musca domestica*, *Stomoxys calcitrans*, and probably other flies). Maturity is reached by the ingestion of the intermediate host by the definitive host. As already mentioned, the larva is of the *Spiroptera* form. It occurs fairly frequently, and is known to infest at least two species of rat fleas.

The objection is, that the parasite occurs chiefly in *Xenopsylla cheopis*, a flea which lives ordinarily in tropical and subtropical regions ; and quite rarely in the common flea *C. fasciatus* which forms such a large percentage of the aphanipterous population of murids in temperate and subtemperate zones and in the colder periods of the year in sub-tropical areas. This objection does not appear to me to be a very serious one, as the parasite does not seem to have been recognised elsewhere, perhaps because unsuspected, perhaps because of the difficulty in seeing it unless very little light be allowed to pass through the specimen.

Stephanurus dentatus, Dies.

The "kidney worm" of pigs was recognised many years ago in Queensland by Morris, in 1871, and by Bancroft

(1893*a*, p. 258). My specimens were forwarded from Ipswich. Immature forms have been fouund by me in the liver.

Agchylostoma caninum, Ercol.

Found locally in dogs and cats. Its presence in dogs in Brisbane (presumably), is inferred from a statement by Dr. Bancroft (1901, p. 41), while I have recorded its occurrence in the dog in N.S. Wales and Victoria. As far as I am aware, this hook-worm is now recorded for the first time as parasitising cats in this continent.

Gigantorhynchus moniliformis, Bremser.

Occurs in *Mus decumanus* and *M. alexandrinus* in Brisbane, but apparently hitherto unrecorded.

Echinorhynchus menuræ, n. sp.

(Pl. IV; Figs. 39, 40).

A single specimen, 19 mm. in length and 1·1 mm. in breadth was taken from the intestine of a lyre-bird, *Menura superba*, near Gosford, N.S. Wales. Owing to the large number of eggs overlying the female organs, very little of the internal anatomy was recognisable.

The parasite has a maggot-like appearance, being somewhat narrower at the anterior end. The body wall is thin and delicate and consequently readily distorted. The small tubular rostellum (Fig. 39) measures about ·16 mm. in diameter, and bears about seven whorls of very numerous, narrow, sharp-pointed hooks, each of which projects about ·04 mm. beyond the surrounding collar. The proboscis sheath is relatively long.

The only part of the female genitalia recognisable is the lower portion of the uterus, or perhaps more correctly, the vagina, which terminates at the gonopore, the latter lying at the base of a concavity. The elliptical eggs measure ·10 by ·031 mm., and the embryos ·068 by ·019 mm.

Echinorhynchus rotundocapitatus, n. sp.

(Pl. IV; Fig. 41).

This species occurs commonly (Johnston, P.L.S., N.S.W., 1909, p. 590; P.R.S., Q'land, 1911, p. 238), in the rectum of the black snake, *Pseudechis porphyriacus*, Shaw, in various parts of New South Wales and Victoria.

The females may reach a length of 32 mm., the males being much smaller (12 mm. long). The body is firm and whitish, the cuticle being smooth or crinkled transversely. The proboscis is nearly spherical, measuring ·76 mm. across, and bearing about seven spirally-arranged series of hooks, each series consisting of twelve to sixteen hooks according to their position on the proboscis. The hooks are powerful structures, consisting of a relatively strong basal portion and of a stout backwardly-projecting hook, surrounded at its base by a small collar. The posterior end of the male is slightly narrowed, and bears the male gonopore. The extremity of the female is slightly swollen and bifid, there being two prominent lobes between which lies the genital aperture.

The following account is taken from a male. The proboscis sheath is an elongate sac 1·6 mm. long. The lemmisci are extremely long, extending through the anterior three-fourths of the parasite. The two rounded testes lie just in front of the middle of the worm. Their long diameter is nearly a millimetre. The vasa deferentia unite to form a large swollen convoluted vesicula seminalis, the lower part of which is a sac-like structure succeeded by the ejaculatory duct. The latter terminates at the small bursa which in turn communicates with the exterior through the male gonopore.

The vagina or uterus is long and thin. Eggs measure ·087 mm. in length, the embryos being ·043 mm. long.

Echinorhynchus, sp.

(Pl. II; Figs. 9, 10).

Last year, I found a larval echinorhynch encysted in the peritoneum lining the body wall of a common golden frog, *Hyla aurea*, near Sydney. The length, excluding the rostellum which measures ·72 mm. when everted, reaches 1·53 mm. The rostellum bears about twelve whorls of hooks, each whorl consisting of about sixteen. The hooks (Fig. 10) possess a stout basal portion, and of a long sharp claw partly surrounded by a collar-like outgrowth of the rostellar cuticle. The entire hook, when measured from the point to the upper end of the base, reaches a length of ·150 mm., of which ·115 mm. protrudes. The rostellar sheath is relatively short, the lemmisci being much longer.

No sex organs were recognisable, but the specimen is probably a female. Although a large number of frogs were examined, parasite was found only once. It thus appears to be rare. I refrain from giving a specific name to this larval form.

LIST OF HOSTS AND THEIR PARASITES, REFERRED TO IN THIS PAPER.

MAMMALIA :—

Mus decumanus	*Hymenolepis diminuta*
(*Epimys norvegicus*)	*Cysticercus fasciolaris*
	Gigantorhynchus moniliformis
	Spiroptera obtusa
	Heterakis spumosa
	Oxyaris obvelata
	Trichodes crassicanda
	Trichosoma hepaticum
Mus rattus (*alexandrinus*)	*Hymenolepis diminuta*
	Cysticercus fasciolaris
	Gigantorhynchus moniliformis
	Spiroptera obtusa
	Heterakis spumosa
	Oxyuris obvelata
	Trichosoma hepaticum
Mus musculus	*Cysticercus fasciolaris*
	Spiroptera obtusa
	Oxyuris obvelata
	Trichosoma hepaticum
Canis familiaris	*Dipylidium caninum*
	Agchylostoma caninum
	Toxocara (*Toxascaris*) *canis*
Felis domestica	*Dibothriocephalus felis*
	Tænia crassicollis
	Dipylidium caninum
	Agchylostoma caninum
	Belascaris mystax
Sus scrofa, dom.	*Stephanurus dentatus*
Bos taurus, dom.	*Fasciola hepatica*
Ovis aries, dom.	*Fasciola hepatica*
Dasyurus viverrinus	*Echinonema cinctum*

Macropus giganteus	*Filaria websteri*
Macropus dorsalis	*F. websteri*
Macropus parryi	*F. websteri*
Onychogale frenata	*Cittotænia bancrofti*, n. sp.

AVES :—

Gallus domesticus	*Hymenolepis carioca*
	Davainea tetragona
	Davainea cesticillus
	Davainea proglottina
	Amœbotænia cuneata
	Heterakis perspicillum
	Heterakis papillosa
Gallopavo meleagris	*Metroliasthes lucida*
Catheturus lathami	*Heterakis catheturinus*, n. sp.
	Heterakis bancrofti, n. sp.
	Echinorhynchus, sp.
Anas superciliosa	*Hymenolepis megalops*
	Diorchis flavescens
	Echinostoma, sp.
Nettion castaneum	*Hymenolepis megalops*
Aythya australis	*Diploposthe lævis*
Chenonetta jubata	*Heterakis chenonettæ*, n. sp.
Notophoyx novæhollandiæ	*Bancroftiella glandularis*
Pelecanus conspicillatus	*Ascaris spiculigera*
Plotus novæhollandiæ	*Microfilaria*, sp.
	Ascaris spiculigera
Phalacrocorax sulcirostris	*Microfilaria*, sp.
	Ascaris spiculigera
Phalacrocorax carbo	*Ascaris*, sp.
Larus canus	*Choanotænia clerci*, nom. nov.
Gymnorhina tibicen	*Filaria clelandi*, n. sp.
Menura superba	*Echinorhynchus menuræ*, n. sp.
Philemon citreigularis	*Filaria*, sp.
Acanthogenys rufigularis	*Filaria*, sp.
Anthochæra carunculata	*Oxyspirura anthochæræ*, n. sp.

REPTILIA :—

Varanus belli	*Hæmogregarina varanicola*
	Acanthotænia tidswelli
	Physaloptera varani ?
Physignathus lesueurii	*Filaria physignathi*, n. sp.
Pseudechis porphyriacus	*Acanthotænia gallardi*
	Echinorhynchus rotundocapitatus, n. sp.
Pseudechis australis	*Acanthotænia gallardi*
Notechis scutatus	*Acanthotænia gallardi*
Denisonia superba	*Acanthotænia gallardi*

AMPHIBIA :—

Hyla aurea	*Ophiotænia hylæ*, n. sp.
	Sparganum, sp.
	Echinorhynchus, sp.
Hyla cœrulea	*Sparganum*, sp.

PISCES :—

Neoceratodus forsteri	*Amphistoma*, sp.
	Amblyonema terdentatum

INSECTA :—

Mastochilus, sp.	*Hystrignathus hystrix*
Musca domestica	*Habronema muscæ* (larva)
M. vetustissima	*H. muscæ* (larva)
Stomoxys calcitrans	*H. muscæ* (larva)
Ceratophyllus fasciatus	*Hymenolepis diminuta* (Cysticercoid)
	Hym. murina (Cysticercoid)
	Agamonema sp. (? larva of *Spiroptera obtusa*)
Xenopsylla cheopis	*Hymenolepis diminuta* (Cysticercoid)
	Hym. murina (Cysticercoid)
	Agamonema, sp. (? larva of *Spiroptera obtusa*)

REFERENCE TO LETTERING.

a., anus ; a.m.p., apical muscle plug ; b., bursa ; c., cirrus ; c.g., cerebral ganglion ; cl., cloaca ; c.s., cirrus sac ; c.w., cyst wall ; cy., cysticercoid ; d.v., dorsal vessel ;

d.v.m., dorso-ventral muscle; e., egg; e.d., ejaculatory duct; e.p., excretory pore; g.c., genital cloaca; gl.c., gland cells; g.p., genital pore; int., intestine; l., lip; lem., lemniscus; l.l., lateral line; l.m., longitudinal muscle; n., nerve; n.r., nerve ring; oes., œsophagus; ov., ovary; p., p.1., p.2., etc., papillæ; ph., pharynx; p.s., proboscis sheath; r., rostellum; r.s., receptaculum seminis; s. sucker; sh., sheath; sp., spicule; t., testis; tr. m., transverse musculature; u., uterus; v., vagina; v.d., vas deferens; v.g., vitelline gland; v.s., vesicula seminalis; v.v., ventral excretory vessel.

Plate II.

Ophiotænia hylæ.

Fig. 1. Scolex.
2. Segment showing genitalia.

Acanthotænia gallardi.

Fig. 3. Segment showing genitalia.
4. Trans. sect. of segment passing through genital ducts.

Sparganum. sp. from *Hyla.*

Fig. 5. Anterior end.
6. Posterior end.

Filaria clelandi.

Fig. 7. Anterior end of a male.
8. Posterior end of a male.

Echinorhynchus, sp. from *Hyla.*

Fig. 9. Entire parasite.
10. Hook from rostellum.

Plate III.

Hymenolepis murina.

Fig. 11. Cysticercoids in *Ceratophyllus fasciatus*

Agamonema, sp.

Fig. 12. Four encysted worms in *Xenopsylla cheopis.*
13. A parasite enclosed in a cyst.

Filaria, sp. from *Philemon.*

Fig. 14. Head end.
15. Tail end.

Microfilaria, sp.

Fig. 16. From *Plotus novæhollandiæ.*
17. From *Phalacrocorax sulcirostris*

Filaria physignatni.

Fig. 18. Head end of male.
19. Head end of female.
20. Portion showing valva.
21. Tail end of female.
22. Tail end of male.

Heterakis catheturinus.

Fig. 23. Anterior end of female.
24. Lips.
25. Tail end of male.

Plate IV.

Heterakis catheturinus.

Fig. 26. Tail end of female.
27. Tail end of male.

Heterakis bancrofti.

Fig. 28. Head end of male.
29. Lips.
30. Tail end of male.

Heterakis chenonettæ.

Fig. 31. Anterior end of female.
32. Lip.
33. Posterior end of male.

Oxyspirura anthochæræ.

Fig. 34. Head end of male.
35. Tail end of male.
36. Tail end of female.

Filaria, sp. from *Acanthogenys*

Fig. 37. Anterior end of female.
38. Posterior end of female.

Echinorhynchus menuræ.

Fig. 39. Anterior end of female.
40. Posterior end of female.

Echinorhynchus rotundocapitatus.

Fig. 41. Entire male worm.

Plate V.

Cittotænia bancrofti.

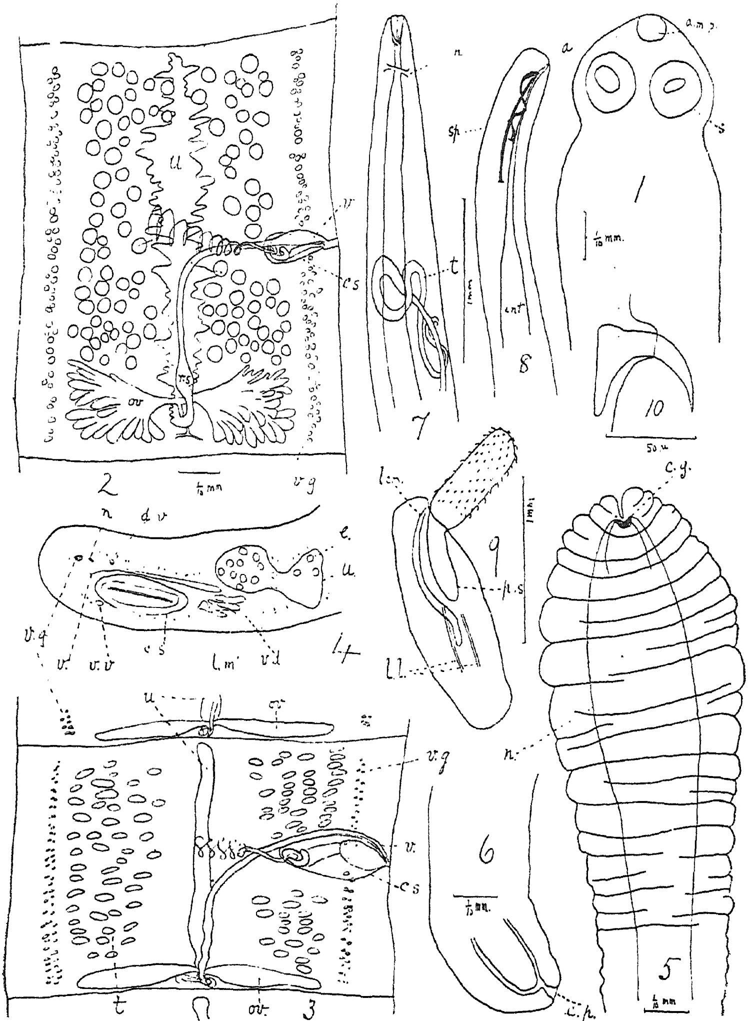
Fig. 42. Portion of segment showing one set of genitalia.

43. Transv. sect. of segment.
44. Longit. horiz. sect. of segment.
45. Scolex.

LITERATURE LIST.

1889 Bancroft—P.R.S., Queensland, 6, 1889, p. 58-62.
1893*a* Bancroft—Austr. Med. Gazette, 12, 1893, p. 258.
1893*b* Bancroft—P.R.S., N.S. Wales, 27, 1893, p. 89.
1901 Bancroft—P.R.S., N.S. Wales, 35, 1901, p. 41-46.
1902 Clerc—Zool. Anz., 1902.
1898 Cobb—Agr. Gazette, N.S. Wales, 9, 1898, p. 296-321.
1910 Cleland and Johnston—P.R.S. South Austr., 34, 1910, p. 100-114.
1910 Gilruth, Sweet & Dodd—P.R.S. Vict., 23, 1910, p. 231-241.
1890 Haswell—P.L.S., N.S. Wales, 5, 1890, p. 661.
1905 Hill—Intercol. Mid. Congr. (Adelaide), 1905, p. 369.
Johnston & Cleland, see also Cleland & Johnston.
1911 Johnston & Cleland—P.L.S., N.S. Wales, 36, 1911, p. 479-491.
1909 Johnston—P.R.S., N.S. Wales, 43, 1909, p. 103-116.
1910 Johnston—P.R.S., 1, N.S. Wales, 44, 1910, p. 84-122.
1911*a* Johnston—Annals Q'land Museum, 10, 1911, p. 175-182.
1911*b* Johnston—P.R.S., Q'land, 23, 1911, p. 233-249.
1911*c* Johnston—P.L.S., N.S. Wales, 36, 1911, p. 47-57.
1912*a* Johnston—Rec. Austr. Museum, 9, 1912, p. 1-35.
1912*b* Johnston—The Emu, Oct. 1912, p. 105-112.
1912*c* Johnston—The present paper.
1873 Krefft—Trans. Entom. Soc., N.S. Wales, 2, 1873.
1851 Leidy—Smithsonian Contrib. Knowl. 5 (2), 1853, 67 pp.
1898 Linstow—In Semon's Forschungsreisen, 5, 1898.
1909 La Rue—Studies Zool. Lab. Univ. Nebraska, No. 95, 1909.
1911 La Rue—Zool. Anz., 38, 1911, p. 473-482.
1909 Minchin—P.Z.S. Lond., 1909, p. 741.
1910 Nicoll & Minchin—P.Z.S., Lond., 1910 (1911), p. 9-13.

1912 Plimmer—J. R. Micr. Soc., Lond., 1912, p. 133-150.
1904 Ransom—Bull 60, B.A. Ind., Dept. Agr., U.S.A., p. 7-54.
1911 Ransom—Science, 34, Nov. 1911, p. 690-2.
1910 Sweet, Gilruth & Dodd, see Gilruth, Sweet & Dodd.
1910 Sweet—P.R.S., Vict., 23, 1910, p. 242-256.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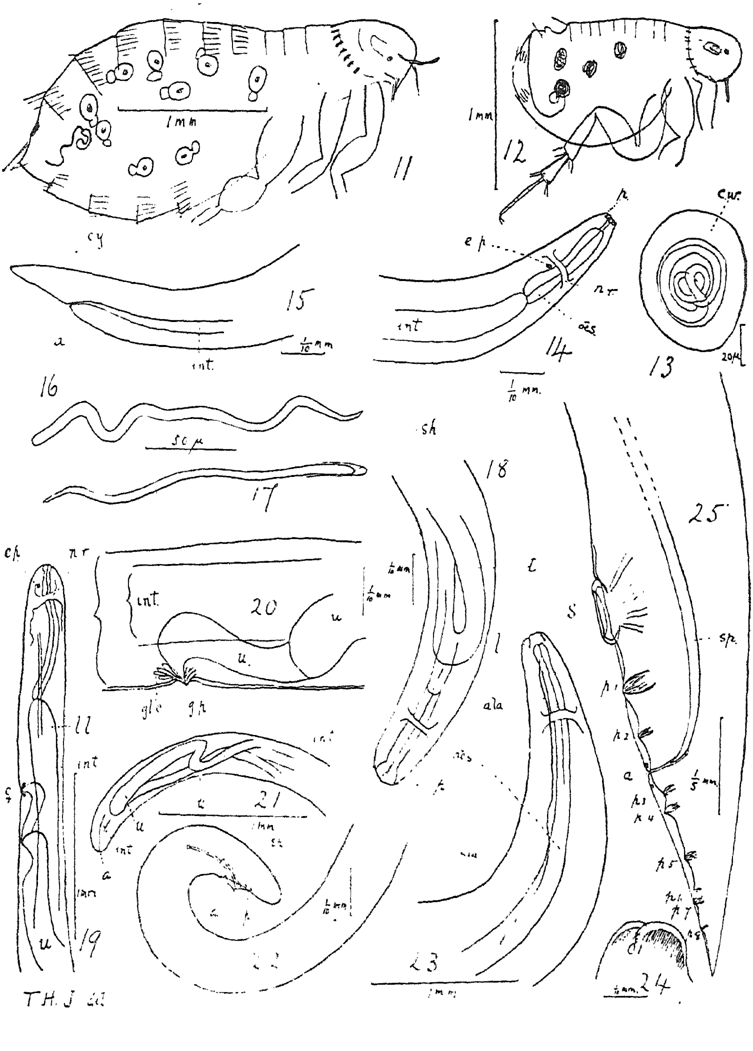

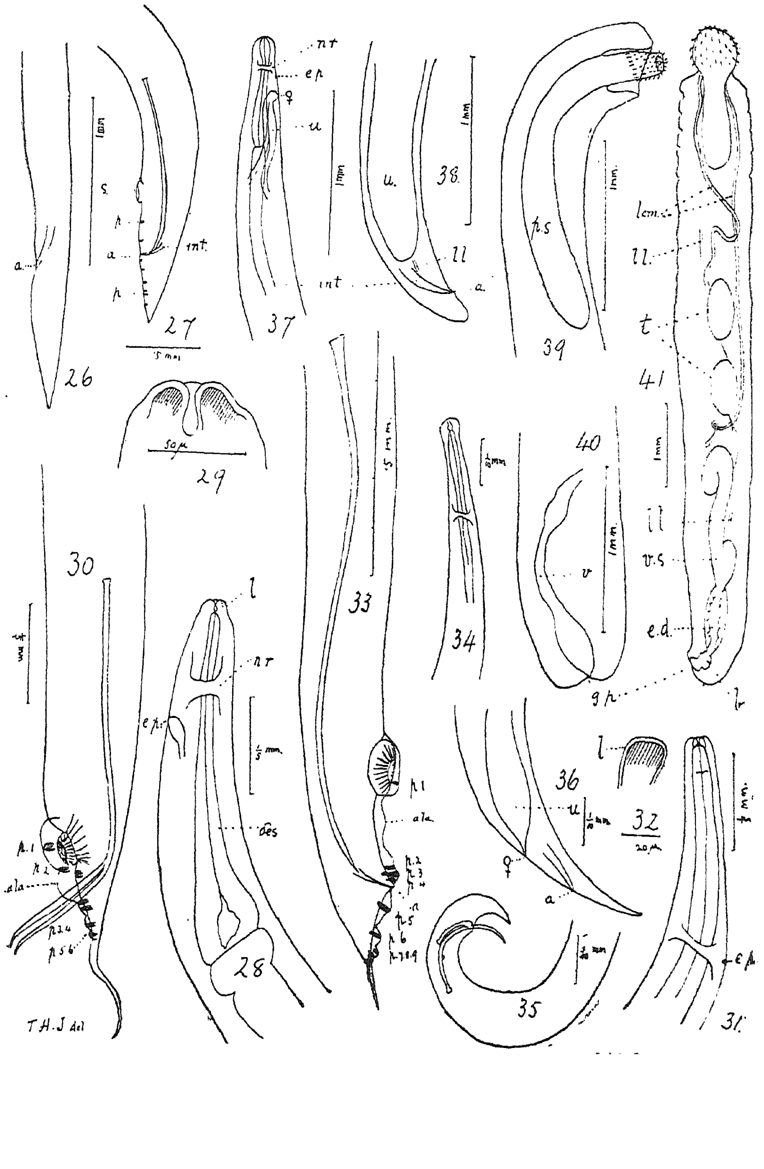
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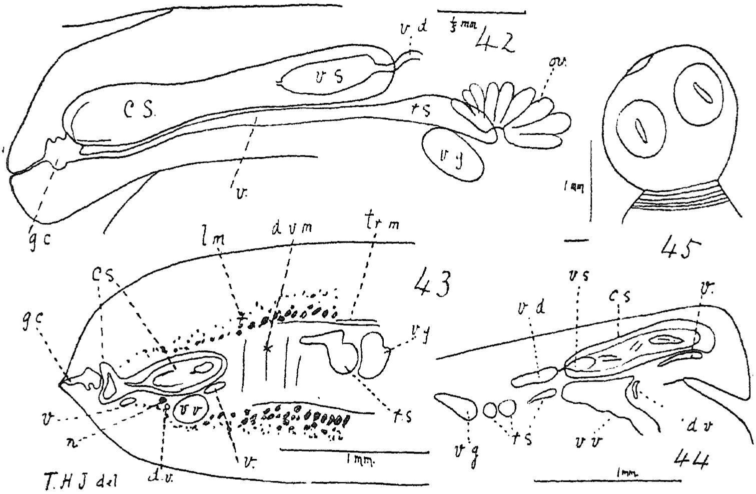
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NOTES ON PORTION OF THE BURDEKIN VALLEY;

WITH SOME QUERIES AS TO THE UNIVERSAL APPLICABILITY OF CERTAIN PHYSIOGRAPHICAL THEORIES.

By E. O. MARKS, B.A., B.E.

(Plates VI, VII, VIII, IX.)

Read before the Royal Society of Queensland, October 2nd, 1912.

THE advances made during recent years in the scientific interpretation of land forms, and through them of the comparatively recent geological history of land surfaces, have not been neglected by Australian scientists. Their work has already proved of great scientific value, but it is sadly hampered by the paucity of information concerning much of the continent, including the majority of Queensland.

Since the consideration of such knowledge as is available concerning the drainage systems of the rivers has drawn particular attention to the courses of the Burdekin and Fitzroy, the writer has taken the opportunity, resulting from a recent visit to the most interesting part of the Burdekin's course, to note some of its characteristics. As the observations made have led him to doubt the correctness of the interpretations put by some on the vagaries of the river as well as the universal applicability of certain physiographical theories, the opportunity is also taken to give the reasons for these doubts.

While calling attention, in doing so, to the need for the utmost caution in applying physiographical reasoning to regions the geological structure of which is but imperfectly understood, it is very far from the writer's intention to belittle, in any way, the value of physiographical studies and reasonings in regions whose outward features and internal structure are reasonably well known.

Among the rivers flowing to the east coast of Australia, the Burdekin with 53,500 square miles is second only in catchment area to the Fitzroy, which drains 55,600 square miles. These two rivers possess a certain amount of similarity in their systems, the complexity of which, as well as their magnitude compared with the other Pacific streams, has drawn the attention of students of Australian physiography.

Of the large area occupied by the Burdekin basin, the writer is only acquainted with that portion which lies within the Charters Towers and Ravenswood goldfields. This, however, includes the Burdekin falls and gorge, where the river passes through the Leichhardt Range, as well as portion of the so-called peneplain upstream from the falls, these two features being the ones to which most attention has been given.*

The Charters Towers and Ravenswood goldfields consist mainly of granite, and possess an undulating surface whose monotony is broken by occasional "monadnocks" of more resistant rocks or by flat-topped "mesas" of a sandstone which, in places, presents lateritic affinities. The undulating country descends gradually to the water courses which thus occupy wide and shallow valleys, conveying the impression of great maturity in the cycle of erosion.

In streams of great maturity, however, one naturally expects to find great widths of alluvial flats, but the Burdekin has, considering its magnitude, deposited very little alluvium.

Another feature not altogether consistent with an advanced stage in the cycle of erosion, is formed by the rocky bars over which the river passes in not infrequent falls of up to 4 or 5 feet.

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*W. Poole, Notes on the Physiography of North Queensland, A.A.A.S., 1909.

C. Hedley, A Study of Marginal Drainage. Pres. Address, Linnean Soc., N.S.W., 1911.

G. Taylor, Physiography of Eastern Australia. Commonwealth Bureau of Meteorology.

J. V. Danes, Physiography of North-Eastern Australia. Royal Bohemian Society of Sciences, 1911.

Between these bars the river is a wide, sandy bed over which the water flows in a quiet and shallow stream from hole to hole. The fall of the river in the 95 miles, between Macrossan Bridge and the top of the falls, amounts to some 400* feet, an average of 4 feet per mile, which is greater than would be expected of a stream of great antiquity. On the other hand the wide sandy bed and quiet stream, like the wide valley, give an impression of old age almost as strong as does a view from one of the few hills in the peneplain which the stream traverses.

The Leichhardt Range through which the Burdekin has cut its gorge consists, from the gorge northwards to near Ravenswood, mainly of various, more or less altered felsitic lavas, tuffs and conglomerates. The country on the east side of the range has a general level some hundreds of feet below that of the country on the western side, as would be expected when consideration is taken of the fact that the water of the streams on the western side has so much greater a distance to travel before reaching the sea than has water on the eastern fall. The eastern streams have, in some instances, eaten far back into the range as for example, near Ravenswood, where the head of the Eight-mile Creek has eaten back to the peneplain on the western side of the range. The divide here is not marked by any prominent ridge as viewed from the western side, but further to the east the mountains attain a much greater elevation than the divide. South of this the range does form the divide, and is considerably higher than the country either to east or west.

As one travels southwards down the Burdekin from near Ravenswood, the Canton Range on the left, approaching within a mile of the river, is an offshoot of the main Leichhardt Range and is composed of felsites. Below Ravenswood station similar rocks constitute the Twins, and form a narrow belt which crosses the river and runs parallel to it on its western side for a few miles forming a

*The levels of the country about the falls were taken with a single aneroid, and must be considered as approximate only. The weather conditions being normal and readings in the same place agreeing closely on different days, while the readings at Ravenswood, before and after an interval of three weeks, were also in accord, the writer is satisfied that the levels noted may be relied on as being reasonably close to the correct altitude.

line of prominent hills. Where the river is crossed the hills on each side of it, would form a gorge were not the width of the river greater than the length of the gorge. Had felsitic rocks occurred here on a more extensive scale, it seems reasonable to presume that a gorge would have existed. It follows, therefore, that the change again to granite country is the cause of the river valley widening out once more to seeming maturity as we proceed downstream. In the reverse order, it is not till a change of country once more occurs, and the hard felsite hills close in to the river that it enters the gorge and passes over the falls that have drawn the attention of physiographers.

On the river's first entering the gorge, the wide, sandy bed gives place to one of bare boulder-strewn rock over which, at ordinary times, the water flows in two streams for perhaps half-a-mile, and then with a drop of 50 or 60 feet forms the two falls illustrated. Below these, within a mile and a-half, the river falls in three or four places another 50 feet, passing through a rocky gorge whose width is the width of the river bed. The sides of the gorge can only be climbed here and there as the lower 100 feet or so are exceedingly steep where not perpendicular. Above this the hills are rounded and rise to the height of some 500 feet above the river on either side.

Further down the river the valley widens out a little here and there, but for 20 miles the river winds its way through mountain ranges from 1500 to 2000 feet in height. The river bed is excessively rough; and to travel down it can only be done on foot (sometimes, probably, with the assistance of the hands) and necessitates swimming the crocodile-haunted stream at frequent intervals, while to journey along the side of the river entails the ascending and descending of spur after spur and mountain after mountain. In the 20 miles of its course through the mountains, there are said to be very few places where cattle can get down to the river, so rough and steep are its banks.

Though so rough as to its bed and steep as to its sides, no further falls are said to occur of more than a foot or two in drop before the river emerges from the ranges and once more assumes the even tenor of its journey to the sea. The

writer did not follow the river further than about 6 miles below the falls, but noticed in one place that the river is divided by an island some 150 feet in height.

It is to be pointed out that the falls total between 100 and 150 feet, while the mountains and hills on either side of the river are of much greater elevation than that part of the peneplain immediately to the west. Thus, at the Suttor confluence the elevation is approximately 350 feet above sea level, while the hills on either side of the gorge rise to elevations of 800 feet near the start and over 1500 feet lower down the river.

Two creeks joining the river in this part of its course pass through gorges before doing so. One of them, Stones Creek, has the upper part of its course mainly in undulating granite country. Of the remainder of its course, part is in fairly open country composed of purplish felsitic tuffs and lavas, while the part nearer the Burdekin, where the rocks are similar to those of the Burdekin gorge, lies also in an almost impassable gorge.

The belt of country formed by the felsitic rocks practically constitutes the Leichhardt Range between the Burdekin Falls and Ravenswood. The country is exceedingly hilly, but the hills are rounded and with the exception of Mt. Bluey, as it is known locally, or Mt. Glenroy, as it is named on the maps, do not form prominent peaks above the general level of the range. The creeks occupy steep-sided V-shaped valleys often difficult to travel along.

At the heads of Glenroy and Stones Creeks areas of granite are marked by the change to the more undulating topography, that at the head of Glenroy forming a tableland on the divide, a tableland from which the creek descends in a waterfall of 300 feet over exceedingly hard granite.

Perhaps the most interesting example of contrast in topography between the two types of country occurs at Plumtree Pocket, about 4 miles south-east of Ravenswood. This pocket is almost entirely surrounded by rounded hills or felsitic rocks traversed by narrow V-shaped valleys. The pocket itself, some 500 feet below the summit of the hills, is approximately 3 miles long by 1 mile wide and is of the usual undulating granite country, almost if not

quite as "old" in appearance as is the peneplain west of the hills. The creek draining it is also of the usual type till it approaches its exit, when it passes between the felsitic hills in a V-shaped valley which is so steep and rough that one cannot ride a horse down it, the track leading from the pocket passing in preference over the hills. The granite which occurs in the ranges is not uniform in character, and in places weathers into rough, boulder-strewn hills, but never with the narrow V-shaped valleys peculiar to the felsites.

The features presented in miniature by Plumtree Pocket are precisely similar to those exhibited by the Burdekin under similar conditions, but on a much larger scale, as well as by Stones and Glenroy Creeks. It is obvious that Plumtree Pocket owes its differentiations from the surrounding hills only to the different weathering powers of the component rocks, and not in any way to a difference in age of denudation.

It appears to the writer necessary to apply this to the Burdekin and conclude that the contrast between the narrow gorge—the type of youth in denudation—and the peneplain—the corresponding type of old age in denudation—is merely due to a difference in the weathering powers of the component rocks.

The river, of course, has a history, and this may possibly yet be puzzled out, but in working out the puzzle undue importance must not, in the writer's opinion, be placed on the existence of the two types of land forms.

Any discussion of the peculiarities in the directions of the tributary streams, the changes in direction of the Burdekin itself, or as to whether the Belyando-Suttor or the Burdekin above their confluence should be considered the main stream, has been purposely avoided in this paper, as the writer is only acquainted with such a small part of the systems, and information is so scant concerning the rest as to render any suggestions that might be made of little value.

As already hinted, the writer suspects that the so-called peneplain is in reality deceptive. That the slope of the river is greater than would be expected in advanced old age, the following table will show, and is an interesting comparison with other Queensland streams.

Declivities of some Queensland Rivers.

River.	Locality.	Level above Sea.	Fall.	Distance.	Feet per mile.
		Feet.	Feet.	Miles.	
Burdekin	Macrossan	695*			
	Falls (above) ..	320*	375	95	4·0
	Falls (below) ..	200	200	100	2·0
	Sea	0			
Belyando (branch at) and Suttor ..	Alpha	1115*			
	Confluence with Burdekin	350	765	260	2·9
Cape River	Cape River Railway Bridge	1228*			
and Suttor ..	Burdekin confluenuce	350	878	140	6·3
Dawson and Fitzroy	Boolburra	156			
	Sea	0	156	180	0·9
Nogoa, Mackenzie and Fitzroy	Emerald	523			
	Sea	0	523	380	1·4
Brisbane (Marongi Creek)	Harlin	313			
	Sea	0	313	160	1·9
Condamine	Killarney	1559			
	Chinchilla .. .. (Charley Creek)	964	595	176	3·4
Condamine, Darling, &c.	Killarney	1559			
	Sea	0	1559	2300	0·68
Warrego	Charleville	876			
	Cunnamulla ..	590	286	150	1·8
Thomson	Torrens Creek ..	1466			
	Longreach	580	886	240	3·7

Note.—With the exception of those marked with an asterisk, which are aneroid measurements, the levels were supplied by the courtesy of Mr. N. G. Bell, Chief Engineer for Railways. The distances were measured on the maps.

The following figures, taken from Geikie's Text Book of Geology, are interesting for comparison.

River.	Fall per mile in feet.
Missouri	2·3
Thames	1·75
Shannon	0·92
Volga	0·25
Colorado in its Cañons	7·72

The conclusion arrived at in regard to the Burdekin basin, that what would ordinarily be considered a youthful and an ancient type of topography are really in all probability of the same denudational age, naturally leads one to review the reasoning on which physiographers have based their classification. For a summary of modern views on the processes of stream erosion, one can hardly do better than refer to Mr. E. C. Andrews' "Erosion and its Significance," read before the Royal Soc. of N.S.W. in 1911. The principles have mainly been evolved by American writers and are fascinatingly told in such works as Chamberlin and Salisbury's Geology or W. N. Davis' Physiography.

A perusal of these writings shews that it is assumed that in a new or rejuvenated land surface, the action of denudation is in effect almost purely mechanical. It is not until the streams are "graded," and thus less active, that the relative importance of weathering action is thought to be sufficiently great to be worth considering.

This assumed predominance of mechanical action is certainly applicable in rocks which are physically soft, but chemically resistant to the atmospheric agencies, or to exceptional conditions in which stream action is very great compared with the decomposition resulting from local rainfall. Thus a large stream passing through an arid region, or a stream possessing such a fall that its corrosive power is very great compared with the work done on its valley sides by the rainfall would certainly approximate in its conditions to the hypothetical cases.

An examination of the usual American illustrations show, in the majority of cases at any rate, that the conditions are such as are mentioned above. For instance, the Grand Cañon of the Colorado is formed by a powerful stream in a region of light rainfall, and is excavated in sedimentary rocks which probably are in their nature, mechanically soft but chemically resistant.

In some text books, in order to illustrate the principles of erosion, an island of regularly dome-shaped surface is supposed to have risen suddenly above the sea and to be subjected to the action of the rainfall. In considering its subsequent history only mechanical erosion is considered.

If now we were to suppose that island to be composed of a rock, uniform in texture and so exceedingly hard, physically, but so readily decomposable that the chemical action alone would be worthy of consideration, what different land forms would result as compared with the usual hypothetical developments!

Of course no rock known possesses these qualities in such extreme proportions, but different rocks do differ very greatly in their relative powers of resistance to weathering and to friction. The ratio exhibited between the resistance offered to these two destructive forces may be termed the weathering factor of the rock, a factor which would necessarily depend on the chemical or mineralogical composition and on the texture of the rock and would vary with conditions of climate.

Some rocks, such as basalt or some coarse-grained granite, being exceedingly hard and resistant to mechanical action, are yet readily subject to disintegration by chemical means. It seems to the writer improbable that the forces of denudation would be capable under ordinary conditions of inducing anything but rounded forms of a "mature" aspect in large areas of such rocks.

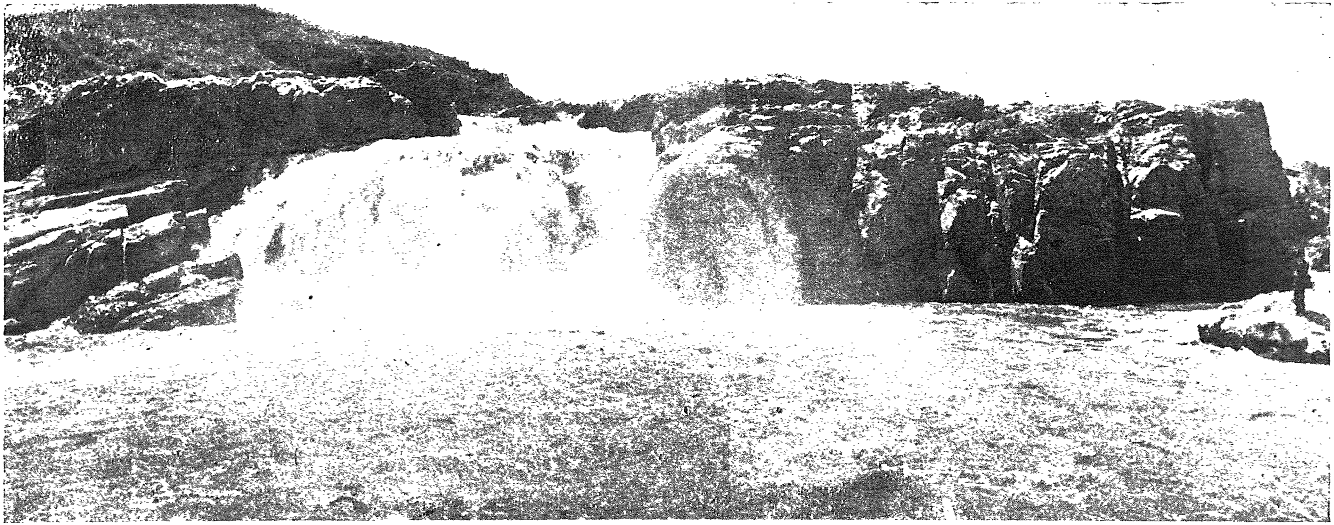
We have, for instance, in North Queensland extensive basalt tablelands which have been dissected by narrow gorges. These gorges have been cut in the arenaceous strata below the basalt and are very narrow with precipitous sides, while the watercourses on the surface of the basalt are mere shallow depressions almost to the edge of the gorge. Residuals of basaltic lava flows of greater age occur both in North and South Queensland, and possess, even where they have evidently been subjected to denudation for long periods, gentle contours on their summits from which the streams descend in waterfalls, being incapable of cutting back gorges or narrow valleys in such rocks.

In the same way the undulating character of part of the Burdekin Valley may be attributed to the weathering factor of its component granite, and not necessarily to a maturity which it may, but quite likely does not, possess. Of course such a granite, if on the edge of a plateau where streams are sufficiently swift and powerful to make light of the natural hardness of the rock, would be excavated

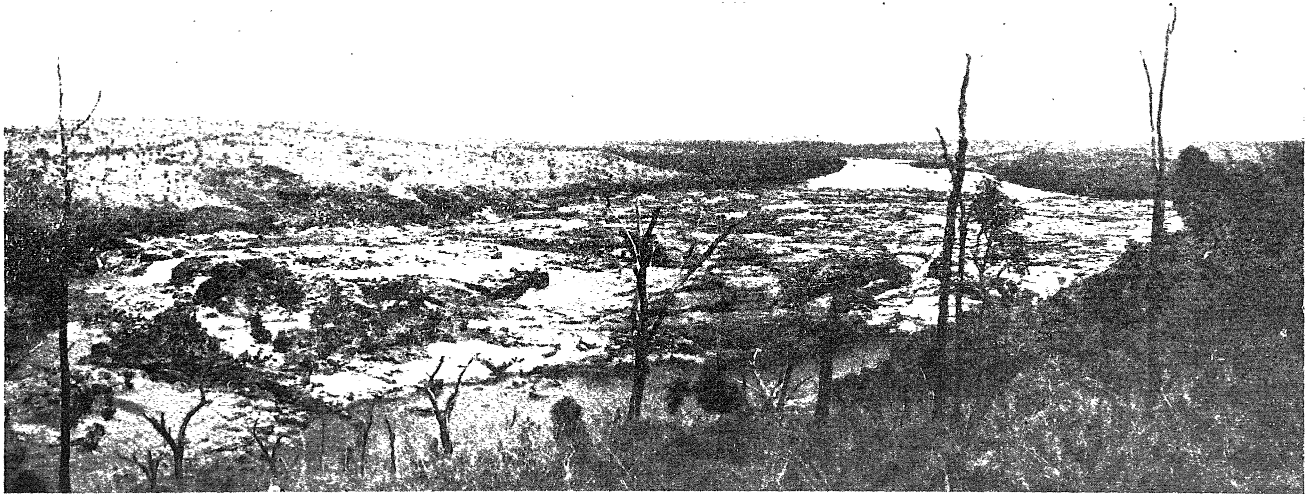
into gorges, but the angle of declivity necessary for the streams to form these gorges would cause them to be short.

While all denuding processes lead eventually to the formation of a plain or, in other words, the reduction of the surface to base levels, and while an approximation to this result is an indication of great age in the cycle of erosion, the writer has come to the conclusion that the nature of some rocks leads to their producing surfaces of low relief having a deceptive appearance of old age.

If this view be correct, the greatest caution is necessary in making physiographical deductions from the mere existance of what appears to be a peneplain, since, without a close acquaintance with its geological structure, one could not be certain that it is due to advanced old age in the cycle of erosion.

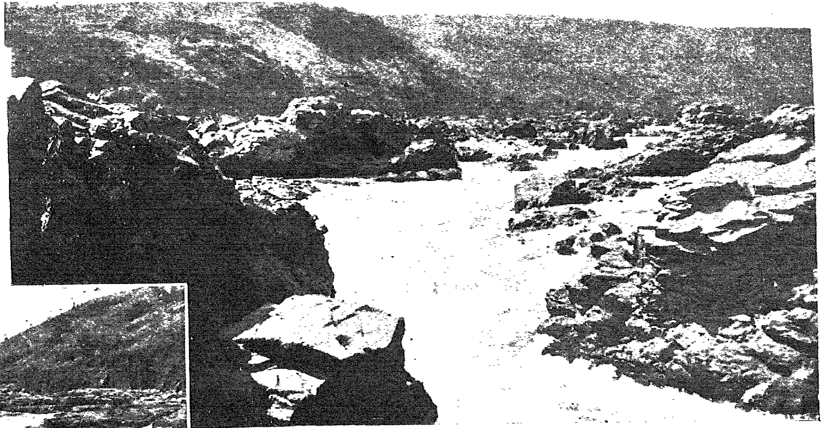


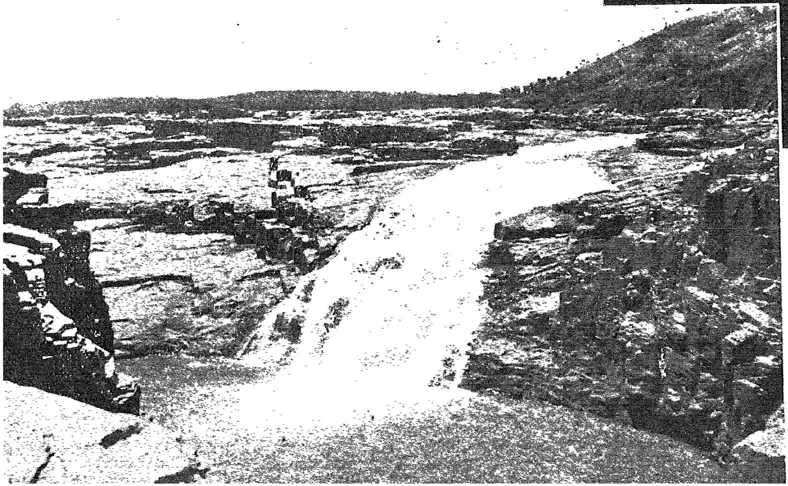
BURDEKIN FALLS, SOUTHERN SIDE OF RIVER.



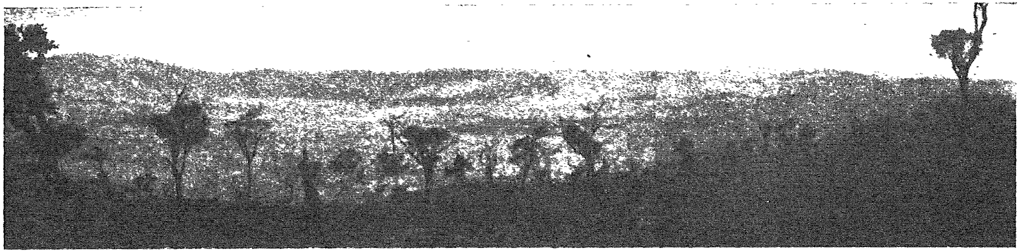
LOOKING UP THE BURDEKIN, SHEWING ENTRANCE TO GORGE AND FALLS.

BURDEKIN GORGE. ONE MILE BELOW FALLS.

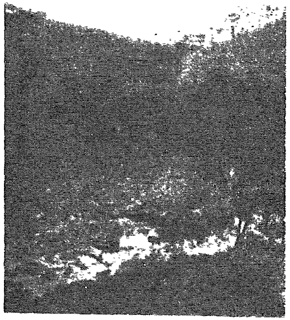




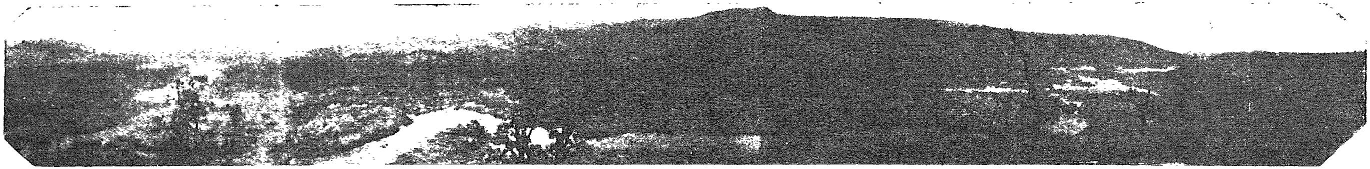
BURDEKIN FALLS, NORTHERN SIDE OF RIVER.



PLUMTREE POCKET.



PLUMTREE CREEK,
AS IT LEAVES THE POCKET.



PANORAMA OF THE BURDEKIN GORGE (LOOKING UP THE RIVER TO THE RIGHT).

A BEETLE THAT TAKES IN BALLAST.

By F. P. DODD.
(KURANDA.)

Read before the Royal Society of Queensland, November 27th, 1912.

FOR some years past, when collecting Coleoptera on the ranges in this and the Herberton districts, my sons and I have frequently taken the females of the large and variable buprest, *Stigmodera regia*, on the ground, always on hot days and when there was some dry dust or fine sand, and, for some time, we were puzzled as to the meaning of its presence there, seeing that the beetle feeds upon the honey of various Eucalyptus trees. As the yellow beetles, and the yellow bands on the varieties gradually changed to dull brown which is often the case with yellow colored beetles I usually eviscerated all of that color, in the hope of preventing such undesirable change. In operating upon *Regia* I often noticed and removed two or three little sacs of fine sand at the extreme tip of the abdomen, but only in the females, invariably in those examples which were rather old and contained but few eggs. This peculiar habit warranted a little investigation, and, as we found other specimens on the ground, we endeavoured to ascertain how the sand was taken in. Though we seldom succeeded in approaching closely to the insects when on the ground, our presence of course alarming them, we were able to ascertain that they curve the abdomen close to the ground, and that the first pair of legs appear to be actively engaged in kicking up the dust, the body at the same time working backward and forward on the other legs. Whether the sand is sucked up by the abdomen-

tip direct from the ground, or is received by it from the kicking front legs, I cannot say (their office may be merely to loosen the sand), but I may have further opportunities of observing during the coming season.

I know of several species of hovering flies (order *Diptera*), which fly closely over the ground, and often drag their abdomen-tips in the dust, and comparatively recently captured a female of a large species whilst so engaged, which I opened and found to contain a quantity of fine earth or sand.

The explanation of the beetle's habit is, I think, quite clear, and, no doubt, the same applies to the flies too. The beetle is much in hilly country, where the winds are strong, and often blow in violent whirling gusts, which are apt to, in fact do, frequently drive and whirl it and flies and other insects out and far from the trees in which they may be feeding. Our beetle, possessing a rather ample or balloon body, and having deposited most of her eggs, and consequently being so much lighter than before, now experiences great difficulty in recovering and flying back to trees in such winds. Moreover the wings of the *Buprestidæ* are generally short and narrow compared with beetles in other families, and the assistance of the elytra is invariably required when in the air, they being raised and held out to help support the insect, as during flight the body inclines downward. To overcome the drawbacks mentioned the sand is taken in, which, lying at the extremity of the body, doubtless effectually ballasts the insect in its beats and struggles against adverse winds.

The *Cetonnidæ*, another flower hunting family, possess much larger flying wings, and do not require the support of the elytra, the wings being slipped out underneath, enabling the insects to bore their way horizontally and swiftly through the air.

Several of the *Buprestidæ* are extraordinarily variable in size and coloring. *Regia* is fairly even in size, except that the females are larger than the males, but the elytra may be all yellow to deep red, or with two or three dark bands with yellow to orange or dark red areas between. Four variable female specimens are forwarded for inspection.

A NOTE ON AUSTRALIAN PEDICULIDS.

By T. HARVEY JOHNSTON, M.A., D.Sc., and LAUNCELOT HARRISON.

Read before the Royal Society of Queensland, November 27th, 1912.

No Pediculids have been described, as far as we know, as occurring on our native fauna, although it is likely that a few species will be found to infest the true Australian *Muridæ*. One is recorded below. Besides this, one may expect to find some on the various species of seals which, at times, frequent parts of the Australian coast. Marsupials apparently do not harbour true lice, their ecto-parasitic insects being Hippoboscids and Mallophaga; the latter, strange to say, belonging to that division of Mallophaga which is mainly parasitic on birds. The bats and flying foxes are parasitised by Nycteribids, as in other parts of the world.

In this note, an attempt is made to give a census of the Pediculids known to occur in Australia. The presence of some species is recorded for the first time.

MAN.

Pediculus capitis, L.

P. vestimenti, Nitzsch.

Phthirius pubis, L.

The presence of the first and third has been referred to on a few occasions in Australian medical journals. Mr. Froggatt (1907) and Mr. Lee (1908) also mention the three, but do not localise them. They are all cosmopolitan species and occur in every State of the Commonwealth. There is no need to make further reference to them.

MACAQUE MONKEY (*Macacus cynomolgus*).

Pedicinus eurygaster.

We have specimens from Sydney and Melbourne Zoological Gardens.

DOG.

Linognathus piliferus.

N.S.W., Victoria, Queensland—not previously recorded though fairly common. The Mallophagan parasite *Trichodectes canis* (*Tr. latus*) also occurs on dogs in Sydney, but is not so frequently met with as the pediculid.

PIG.

Hæmatopinus suis, L. (syn. *H. urius*).

Tasmania, Victoria, N.S.W., Queensland, West Australia. Lea (1908, p. 105) recorded the presence of this common parasite in Tasmania.

CATTLE.

Linognathus vituli, L.

Hæmatopinus eurysternus, Nitzsch.

The former, the calf louse, was incidentally recorded by one of us (Johnston, 1911, p. 217, footnote—N.S.W.), and by Gilruth and Sweet (1911, p. 29; 1912, p. 28). We have specimens from N.S.W., Victoria and Queensland.

The latter species has been recorded by Gilruth and Sweet (1912, p. 28), presumably from Victoria. We have specimens from N.S.W., Victoria and Queensland.

Lea (1908, p. 104) records the presence of both in Tasmania.

CAMEL (Dromedary).

Hæmatopinus tuberculatus, Burm.

We have identified as belonging to this species some specimens found by Dr. J. B. Cleland on a camel imported into North West Australia from India. Neumann (1909, p. 497) gives a description and refers (p. 498) to the finding of this species, which normally

parasitises the buffalo, on a camel in Australia (Nuttall's collection). As Dr. Cleland forwarded specimens to Prof. Nuttall also, it may be assumed with safety that it was these stragglers from West Australia that Neumann had before him. It is a pity that the name of the collector was not indicated, in the case of this interesting find.

HORSE.

Hæmatopinus asini, L.

N.S.W.—Collected by Mr. A. S. Le Souef.

Lea (1908, p. 104) mentions the species, but does not state whether it occurs in Tasmania.

SHEEP.

Linognathus ovillus, Neumann.

N.S.W., South Australia. Not previously recorded from Australia. This parasite has been recognised by one of us as occurring, though rarely, on sheep in certain localities of New South Wales. Mr. Desmond, Government Veterinarian, Adelaide, has recently forwarded the same species for determination, from two widely separated localities in South Australia. In 1906 Dr. Gilruth (1906, p. 309) met with it in New Zealand and figured it as *Hæmatopinus*, sp. Neumann later described it as *H. ovillus*, Gilruth giving a resume of the description in 1908.

RABBIT.

Hæmodipsus ventricosus, Denny.

N.S.W. This species is now recorded for the first time as occurring in the Commonwealth. Our specimens were collected in Sydney from rabbits sent from the southern district of N.S. Wales.

MOUSE.

Though pediculids have been carefully searched for, none have yet been found by us on this host.

RATS. (*Mus rattus* (*alexandrinus*) and *Mus decumanus*.)

Polyplax spinulosus, Burm.

Recorded from both hosts, from Sydney, by one of us (Johnston, 1910, p. 20), who has specimens from Melbourne and Brisbane also from these two species of rats.

Neumann (1909, p. 515-7) has described a new species *Hæmatopinus* (*Polyplax*) *bidentatus* as infesting a *Mus rattus* from Lake Torrens, South Australia (Rothschild collection). In connection with this form Dr. Cleland has made certain inquiries, the result of which has been to make known the following facts. Dr. Borthwick, Commissioner of Public Health, Adelaide, forwarded to the Hon. Rothschild, through Professor Stirling, Director of the Adelaide Museum, a collection of ectoparasites from rats. Amongst them were fleas from the common rats, and pediculids from a water rat, *Hydromys chrysogaster*, captured at Torrens Lake, a sheet of fresh water in the vicinity of Adelaide. Lake Torrens is a depression, sometimes containing saline water, in the central portion of South Australia. It is safe to assume that this is the collection which Professor Neumann handled. The host of this new species of pediculid is thus an Australian rat and, not, as far as we are aware, the introduced house rat *Mus rattus*. Owing to the collector's name not having been recorded along with the description, some difficulty might have been experienced in tracing the specimens but for Dr. Cleland's kindness. One of us has received from the Bureau of Microbiology, Sydney, a pediculid, one millimetre long, taken from *H. chrysogaster*, caught on the shore of Sydney Harbour. The head is injured, but the general form of the parasite agrees with that described by Neumann. The setæ on the pleura are longer in our specimen, as they extend beyond the stigmata.

WATER RAT. (*Hydromys chrysogaster.*)

Polyplax bidentatus, Neumann.

S. Australia, Sydney.

(See under *Mus rattus* and *decumanus.*)

No doubt many of the forms here recorded as occurring in certain States of Australia are also present in others.

Mr. A. S. Le Souef and Dr. Cleland of Sydney, and Mr. Desmond, of Adelaide, have been kind enough to forward material to us.

1907 Froggatt—Australian Insects, Sydney.
1906 Gilruth—Ann. Rep. Dept. Agric., New Zealand, 1906.
1908 Gilruth—Ann. Rep. Dept. Agric., New Zealand, 1908.
1911 Gilruth and Sweet—*Onchocerca gibsoni*, etc—(Commonwealth Govt.), Sydney, 1911.
1912 Gilruth and Sweet—Proc. Roy. Soc., Victoria, 25, 1912.
1910 Johnston—Ann. Rep. Bureau Microbiology, Sydney, 1909 (1910).
1911 Johnston—Proc. Roy. Soc., Queensland, 1911, p. 207.
1908 Lea—Insect and Fungous Pests, etc., Hobart. Edit. 3. 1908.
1909 Neumann—Arch, d. Parasitol, 13, 1909, p. 497.

STUDIES IN AUSTRALIAN LEPIDOPTERA, PYRALIDÆ.

By A. JEFFERIS TURNER. M.D. F.E.S.

Read before the Royal Society of Queensland, 27th November, 1912.

MANY species of this family, especially in the subfamilies *Pyranstinæ* and *Phycitinæ*, have a wide distribution from Queensland through the Malayan Archipelago to China and India, and even to Africa. There is consequently in describing Australian species as new a risk of creating synonyms. I hope I have not often erred in this direction. I have many species which I have thought it more prudent to leave undescribed. In some instances I have been able to send duplicate specimens to the British Museum, and so obtain the assistance of Sir Geo. Hampson's valuable opinion.

Subfam. PHYCITINÆ.

HYPSOTROPHA NIPHOPLEURA, *n. sp.*

νιφοπλευρος, with snowy costa.

♂ ♀. 10-14 mm. Head fuscous. Palpi fuscous; in ♂ moderate (3), in ♀ long (6). Antennæ fuscous; in ♂ with a broad notch containing rough scales on upper surface near base. Thorax fuscous. Abdomen grey, dorsum of basal segments ochreous. Legs fuscous. Forewings narrow, costa moderately arched, apex rounded, termen very obliquely rounded; fuscous, in ♀ sometimes reddish-tinged; a broad, white costal streak narrowing at base and apex, sometimes containing a fine central fuscous streak; costal edge fuscous near base, sometimes as far as $\frac{2}{3}$; cilia fuscous. Hindwings and cilia whitish.

Type in Coll., Turner.

N.A. Port Darwin, from November to February; a series received from Mr. F. P. Dodd.

HYPSOTROPHA NIPHOSEMA, *n. sp.*

νιφοσημος, snow-marked.

♂ ♀. 18-20 mm. Head dark-fuscous. Palpi very long in both sexes (♂ 5, ♀ 7); dark-fuscous. Antennæ fuscous; in ♂ thickened and dentate, with a broad notch filled with rough scales on dorsal surface near base. Thorax dark-fuscous. Abdomen grey; dorsum except near apex ochreous. Legs fuscous. Forewings narrow, costa moderately arched, apex round-pointed, termen very obliquely rounded; dark-fuscous, in ♀ sometimes reddish-tinged; a whitish or ochreous-whitish costal streak, narrower towards base, and ending in a point at apex; costal edge more or less fuscous; cilia dark-fuscous. Hindwings grey-whitish, darker towards apex; cilia whitish.

Like the preceding but considerably larger, the ♂ palpi longer, and the ♂ antennæ dentate. Vein 10 of forewings may be either stalked or separate, so that I doubt whether the genus *Hypsotropha* as defined by Hampson can be maintained.

Type in Coll., Turner.

N.A. Port Darwin, in November and December: five specimens received from Mr. F. P. Dodd.

HYPSOTROPHA DYSEIMATA, *n. sp.*

δυσειματος, meanly clad.

♂ ♀. 15 mm. Head fuscous-whitish or ochreous-whitish. Palpi very long (♂ 4, ♀ 6); ochreous-whitish mixed with fuscous. Antennæ ochreous-whitish, in ♂ with a broad notch containing rough scales on upper surface near base, ciliations minute. Thorax ochreous-whitish. Abdomen ochreous-whitish; dorsum of basal segments ochreous. Legs ochreous-whitish; anterior and middle pairs fuscous in ♂. Forewings narrow, costa moderately arched, apex rounded, termen obliquely rounded; ochreous-whitish, sometimes reddish-tinged with some dark-fuscous scales; a dark-fuscous subdorsal dot before middle, another before tornus, and traces of a dark-fuscous line between this and apex; a terminal series of dark-fuscous dots; cilia ochreous-whitish. Hindwings grey; in ♀ whitish; cilia whitish.

Type in Coll., Turner.

N.A. Port Darwin in October and December and January; a series received from Mr. F. P. Dodd.

HYPSOTROPHA LAROPIS, *n. sp.*

λαρωπις, of dainty appearance.

♀. 17 mm. Head whitish-ochreous. Palpi rather long (4); whitish with a few pinkish scales. Antennæ ochreous-whitish. Thorax pinkish. Abdomen ochreous-whitish; dorsum of basal segments ochreous. Legs ochreous-whitish. Forewings very narrow, costa slightly arched, apex rounded, termen obliquely rounded; rose-pink, becoming whitish towards dorsum; veins slenderly whitish; a broad white costal streak from base, narrowing to a point at apex, containing a costal and subcostal fine pink lines; cilia pink. Hindwings and cilia whitish.

Type in Coll., Turner.

N.A., Port Darwin in November; one specimen received from Mr. F. P. Dodd.

HYPSOTROPHA NEURICA, *n. sp.*

νευρικος, with marked nerves.

♂ 24 mm. Head pinkish. Palpi long (5); fuscous. Antennæ ochreous-whitish; in ♂ thickened and dentate, with a broad groove containing rough scales on dorsal surface near base. Thorax, abdomen and legs pinkish-grey. Forewings elongate, costa strongly arched, apex rounded, termen obliquely rounded; dull-pink, towards termen, mixed with fuscous; area of cell and all veins ochreous-whitish; cilia pinkish-white. Hindwings grey; towards base whitish; cilia whitish.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in June; one specimen.

ANERASTRIA SYSSEMA, *n. sp.*

συσσημος, similarly marked.

♀ 12-15 mm. Head whitish-ochreous. Palpi in ♀ long (6); fuscous. Antennæ whitish-ochreous. Thorax grey. Abdomen grey; dorsum of basal segments ochreous. Legs whitish-ochreous; anterior pair fuscous. Forewings narrow, costa strongly arched, apex rounded, termen obliquely rounded; brown-whitish; a broad white costal streak, narrowing towards base and apex, containing a few fuscous scales towards apex; costal edge narrowly

fuscous ; last costal, median, and submedian veins outlined by fuscous irroration ; a fuscous terminal line ; cilia whitish irrorated with fuscous. Hindwings and cilia whitish.

Type in Coll., Turner.

N.A. Port Darwin, in November and January ; six specimens received from Mr. F. P. Dodd.

ANERASTRIA METALLACTIS.

Anerastria metallactis, Meyr., Tr. E.S. 1887, p. 262.

♀ 15-20 mm. Head, palpi, and antennæ brown-whitish ; palpi long (5). Thorax brown-whitish. Abdomen whitish-ochreous. Legs ochreous-whitish ; anterior pair brown-whitish. Forewings elongate, not narrow ; costa gently arched, apex rounded, termen obliquely rounded ; pale whitish-brown ; most of the veins defined by whitish lines, which are powdered with fuscous scales ; a fuscous spot at lower external angle of cell ; cilia whitish. Hindwings whitish-grey ; cilia whitish.

In spite of the difference in locality, I think this must be Mr. Meyrick's species.

N.A. Port Darwin, in October, November and December ; five specimens received from Mr. F. P. Dodd, N.S.W., Bathurst (Meyrick).

ANERASTRIA ABLEPTA, *n. sp.*

ἄβλεπτος, inconspicuous.

♂ ♀ 20-25 mm. Head and thorax brown-whitish. Palpi in ♂ rather long (4), in ♀ very long (7) ; brown-whitish, irrorated or suffused with fuscous. Antennæ brown-whitish ; in ♂ thickened with minute ciliations, a broad groove containing rough scales on dorsal surface near base. Abdomen ochreous. Legs brown-whitish, sometimes irrorated with fuscous. Forewings elongate, costa strongly arched, apex rounded, termen obliquely rounded ; pale whitish-brown, with a few scattered fuscous scales ; a median whitish streak along lower edge of cell to ⅗ ; veins towards termen sometimes obscurely whitish ; a terminal series of fuscous dots, often inconspicuous ; cilia whitish. Hindwings grey or whitish-grey ; towards base whitish ; cilia whitish.

Vein 10 usually separate, in one specimen short-stalked.

Type in Coll., Turner.

N.A. Port Darwin, in November, December, and February. Q. Bunya Mts. in December; Brisbane in March; Mt. Tambourine in November.

ANERASTRIA ARGOSTICHA, *n. sp.*

ἀργοστιχος white-lined.

♀ 14 mm. Head whitish-ochreous. Palpi moderate (3); pale-fuscous, towards base whitish. Antennæ whitish-ochreous. Thorax pinkish. Abdomen whitish; dorsum of basal segments ochreous. Legs ochreous-whitish; anterior pair pale-fuscous. Forewings moderately elongate, costa moderately arched, apex rounded, termen obliquely rounded; pinkish; veins slenderly whitish; a white median streak from near base to near termen, its anterior ⅔ edged dorsally with fuscous; cilia whitish with a fuscous sub-basal line. Hindwings grey-whitish; cilia whitish with a pale-grey sub-basal line.

Type in Coll., Turner.

N.A. Port Darwin, in December; one specimen received from Mr. F. P. Dodd.

ANERASTRIA ENERVELLA.

Erythphlebia enervella, Rag., Rom. Mem. viii., p. 394, Pl. 39, f. 24.

♂ 20-24 mm. Head and thorax pinkish. Palpi in ♂ rather long (4); pale-fuscous. Antennæ whitish-ochreous; in ♂ thickened, ciliations ½, with a dorsal groove filled with rough scales near base. Abdomen ochreous-whitish; dorsum of basal segments ochreous. Legs pale-fuscous; posterior pair mostly ochreous-whitish. Forewings moderately elongate, costa strongly arched, apex rounded, termen obliquely rounded; pinkish; veins whitish more or less edged with fuscous scales; a median whitish streak from near base to termen, becoming gradually broader to mid-disc and remaining broad to termen, from mid-disc it is divided by a fine median pinkish streak; a fuscous streak from base along lower edge of median streak to middle; a terminal series of fuscous dots; cilia pinkish-

white. Hindwings whitish; an interrupted fuscous line along apical half of termen; cilia whitish.

N.A. Port Darwin, in February; one specimen received from Mr. F. P. Dodd. Q. Eumundi near Nambour, in December, one specimen.

ANERASTRIA ANÆMOPIS, *n. sp.*

ἀναιμωπις, pale, bloodless.

♀ 18 mm. Head, thorax and antennæ brown-whitish. Palpi in ♀ moderately long (5); brown-whitish with some fuscous irroration. Abdomen ochreous-whitish; dorsum of basal segments ochreous. Legs whitish; anterior pair fuscous. Forewings moderately elongate, costa moderately arched, apex rounded, termen obliquely rounded; brown-whitish, with a few scattered dark-fuscous scales, mostly towards termen; a roundish suffused fuscous sub-dorsal spot before middle, and a second similar on dorsum before tornus; cilia brown-whitish. Hindwings grey-whitish; cilia white, with a grey-whitish sub-basal line.

Type in Coll., Turner.

N.A. Port Darwin, in November; one specimen received from Mr. F. P. Dodd.

ANERASTRIA BALIORA, *n. sp.*

βαλιορος, speckled.

♀ 18 mm. Head and thorax pale-pinkish. Palpi in ♀ very long (8); pinkish-white suffused with pale-fuscous; under surface whitish. Antennæ whitish. Abdomen whitish; dorsum of basal segments ochreous. Legs whitish; anterior pair fuscous on dorsal aspect. Forewings elongate, costa rather strongly arched, apex round-pointed, termen slightly rounded, strongly oblique; pale pinkish with a few scattered dark-fuscous scales; all veins outlined in whitish; a dark-fuscous dot on sub-median vein at $\frac{1}{4}$, and a second before tornus; smaller dots on veins 2, 3, and 4 before their middle; cilia white. Hindwings whitish; cilia white.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns in November; one specimen received from Mr. F. P. Dodd.

ANERASTRIA ACROPHÆA, *n. sp.*

ακροφαιος, dusky at the apex.

♂ 17 mm. Head and thorax pinkish-fuscous; face with a long dense tuft of anteriorly projecting hair-like scales. Palpi fuscous; in ♂ moderate ($3\frac{1}{2}$), terminal joint strongly down-curved. Antennæ whitish-ochreous, towards base fuscous; in ♂ thickened and slightly dentate, with short ciliations ($\frac{1}{3}$), a broad sub-basal dorsal groove containing rough scales. Abdomen ochreous; towards apex paler; under-surface fuscous. Legs fuscous. Forewings scarcely elongate, costa strongly arched, apex round-pointed, termen slightly rounded, strongly oblique; whitish suffused with brown-pinkish; irrorated rather densely with dark-fuscous scales towards base and termen; towards the latter this tends to form interneural streaks, of which that running into apex is best marked; cilia grey-whitish, at apex mixed with fuscous. Hindwings dark-grey; cilia whitish with a grey sub-basal line.

Type in Coll., Turner.

N.A. Port Darwin, in November; one specimen received from Mr. F. P. Dodd.

ANERASTRIA PLEUROCHORDA, *n. sp.*

πλευροχορδος, with costal line.

♀ 22 mm. Head ochreous-brown; face white. Palpi in ♀ long (5); brown. Antennæ pale-brown. Thorax brown. Abdomen brown; dorsum of basal segments pale-ochreous. Legs fuscous; [posterior pair broken]. Forewings elongate, costa rather strongly arched, apex rounded, termen obliquely rounded; pinkish-brown; a broad costal whitish streak narrowing towards base and at apex; cilia whitish. Hindwings and cilia whitish.

Type in Coll., Turner.

Q. Stanthorpe, in January; one specimen.

ANERASTRIA ERASMIA, *n. sp.*

ερασμιος, lovely.

♀ 26 mm. Head, palpi, and thorax bright crimson-pink; palpi in ♀ long (5). Antennæ ochreous-whitish. Legs pinkish; tarsi fuscous; posterior tibiæ and dorsal surface of tarsi ochreous-whitish. Forewings elongate,

costa strongly arched, apex round-pointed, termen but slightly rounded, oblique; bright crimson-pink; towards dorsum suffusedly whitish; a slender whitish median streak from near base to $\frac{3}{4}$; cilia crimson-pink. Hindwings grey-whitish; cilia whitish.

Type in Coll., Turner.

N.Q. Herberton, in February; one specimen received from Mr. F. P. Dodd.

POUJADIA CTENUCHA, *n. sp.*

κτενουχος, bearing a comb.

♂ 17-18 mm. Head and thorax reddish-brown. Palpi moderate (3); fuscous mixed with brown-whitish. Antennæ with long pectinations (3), not extending to apex; brown-whitish. Abdomen whitish; dorsum of basal segments ochreous. Legs whitish; anterior pair fuscous. Forewings not elongate, costa gently arched, more strongly towards apex, apex rounded, termen obliquely rounded; ochreous-whitish or sometimes reddish; variably irrorated and suffused with dark-fuscous; usually a broad whitish costal streak from base to $\frac{5}{6}$, containing some fuscous scales, but often this is entirely obscured by the ground-colour; a terminal series of fuscous dots, sometimes obscure; cilia whitish. Hindwings whitish, suffused with grey towards apex, and with a dark-grey terminal line not reaching tornus; cilia whitish.

♀ 18-20 mm. Palpi rather long (5). Forewings with less fuscous irroration; costal streak well-defined and without irroration.

Type in Coll., Turner.

N.A. Port Darwin, from September to January; eight specimens received from Mr. F. P. Dodd.

POUJADIA LEUCONEURA, *n. sp.*

λευκονευρος, white-nerved.

♀ 30 mm. Head and thorax pale-pinkish. Palpi moderate (3); fuscous-whitish. Antennæ white. Abdomen whitish; dorsum of basal segments ochreous. Legs whitish. Forewings moderately broad, costa moderately arched, apex rounded-rectangular, termen slightly oblique, rounded beneath; whitish-ochreous with some pink scales; all

veins outlined in white which is edged by interneural pale-fuscous streaks; submedian vein edged with pink and interrupted by a pale-fuscous dot at $\frac{1}{3}$; a pale-fuscous longitudinal streak through cell; cilia whitish. Hindwings grey-whitish; cilia whitish.

Type in Coll., Turner.

N.A. Port Darwin, in March; one specimen received from Mr. F. P. Dodd.

Gen. DIALEPTA, nov.

διαλεπτος, very small.

Tongue present. Palpi recurved, ascending, reaching vertex, tolerably pointed. Forewings with nine veins, 3 and 4 stalked, 5 absent, 8 and 9 coincident, 10 separate. Hindwings with six veins, cell closed, 4 absent, 5 absent, 7 running into 8.

Dialepta micropolia, *n. sp.*

μικροπολιος, small grey.

♀ 8 mm. Head and thorax grey. Palpi fuscous; bases of joints whitish. Abdomen whitish-grey. Legs grey with obscure whitish annulations. Forewings narrow, somewhat dilated posteriorly, costa slightly arched, apex rounded, termen obliquely rounded; grey mixed with whitish; a transverse grey line at $\frac{1}{4}$; succeeded by a squarish grey subcostal spot; an obscure sinuate grey subterminal line; an interrupted fuscous terminal line; cilia grey with whitish dots. Hindwings whitish-grey; cilia whitish.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in November; one specimen received from Mr. F. P. Dodd.

Gen. ECBLETODES.

Ecbletodes, Turn., P.R.S.Q., 1903, p. 124.

Tongue well-developed. Antennæ in ♂ slightly serrate towards apex, ciliations minute. Palpi erect, appressed to frons, exceeding vertex, tolerably acute. Forewings with 4 and 5 connate or short stalked, 9 absent, 8 and 10 stalked. Hindwings with 3 and 4 connate or stalked, 5 absent, 7 running into 8.

Allied to *Ephestia* and *Homœosoma*, but with very distinct neuration. The neuration is given erroneously in my original description.

ECBLETODES ÆNICTA, *n. sp.*

αἴνικτος, obscure.

♂ ♀ 14 mm. Head, antennæ, thorax, and abdomen ochreous-whitish. Palpi ochreous-whitish with some fuscous scales. Legs ochreous-whitish; anterior tibiæ and tarsi fuscous. Forewings narrow, costa rather strongly arched, apex rounded, termen obliquely rounded; ochreous-whitish with some fuscous suffusion; a fuscous spot on base of dorsum; a broadly-suffused fuscious fascia from $\frac{5}{6}$ costa to $\frac{3}{4}$ dorsum; followed by a pale line, beyond which terminal part of disc is suffused with fuscous; cilia grey. Hindwings and cilia grey.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October, May and June; Stannary Hills; eight specimens.

ECBLETODES OTOPTILA, *n. sp.*

ὠτόπτιλος, with eared wing.

♂ 12 mm. Head, palpi, and thorax brown-whitish mixed with fuscous. Antennæ fuscous; ciliations in ♂ imperceptible. Abdomen brown-whitish; dorsum, except a series of median spots, fuscous. Legs brown-whitish mixed with fuscous. Forewings moderate, costa strongly arched, apex rounded, termen obliquely rounded; brown-whitish; markings and a few scattered scales dark-fuscous; a very obscure sinuate line from $\frac{5}{6}$ costa to $\frac{5}{6}$ dorsum; a short longitudinal streak above middle of disc running into this; a short oblique streak also running into it above dorsum; a terminal series of interneural streaks; cilia grey with whitish dots. Hindwings with a basal costal lobe formed by an abrupt excavation of costa at $\frac{1}{4}$, containing a curled tuft of long hairs, the costal portion of disc beyond vein 7 being not developed; dark-grey; cilia grey.

Very obscure, but easily recognised by the highly peculiar hindwings, which are however probably only a sexual characteristic.

N.A. Port Darwin, in September; one specimen received from Mr. F. P. Dodd.

GEN. CRYPTADIA, NOV.

κρυπταδιος, hidden.

Tongue well-developed. Palpi ascending, appressed to frons, reaching vertex; terminal joint well-developed, tolerably pointed. Forewings with 3 and 4 stalked, 5 absent, 8 and 9 stalked, 10 separate. Hindwings with cell very short ($\frac{1}{3}$); 2 from well before angle of cell, 3 and 4 short-stalked, 5 absent, 7 running into 8.

Best distinguished from *Euzopherodes* by the extreme shortness of cell of hindwing.

CRYPTADIA XUTHOBELA, *n. sp.*

ξουθοβελος, with tawny weapons (palpi).

♀ 18-20 mm. Head and thorax fuscous. Face and palpi orange-ochreous. Abdomen and legs fuscous. Forewings elongate, posteriorly dilated, costa strongly arched, apex rounded, termen obliquely rounded; fuscous, with dark-fuscous dots; a dot on costa at $\frac{1}{3}$, another above dorsum at $\frac{2}{3}$, and a third between but slightly posterior to these; a median discal dot; a dot on dorsum before tornus, another above this, and two in disc placed transversely, slightly posterior to the preceding; cilia fuscous. Hindwings grey-whitish; cilia whitish.

Type in Coll. Turner.

N.Q. Kuranda, in September, October and March; five specimens received from Mr. F. P. Dodd.

EUZOPHERODES SPODOPTILA, *n. sp.*

σποδοπτιλος, ashen-winged.

♂ 14 mm. Head and thorax whitish-grey. Palpi fuscous; apices of second and terminal joints whitish. Antennæ whitish; ciliations in ♂ $\frac{1}{3}$. Abdomen grey; basal segments and tuft ochreous-whitish. Legs whitish-grey with fine fuscous irroration. Forewings narrow, costa rather strongly arched, apex rounded, termen obliquely rounded; whitish-grey with some fuscous irroration; a suffused sub-basal fuscous spot from costa, not reaching dorsum; a similar suffused transverse fascia at $\frac{2}{5}$; a fine fuscous line at $\frac{5}{6}$ angled into a prominent posterior tooth in mid-disc; an obscure terminal series of fuscous dots;

cilia whitish-grey. Hindwings whitish; suffused with grey towards apex and termen; cilia whitish with a grey sub-basal line, at apex grey.

In wing-shape this resembles *E. leptocosma*, from which, however, it is very distinct.

N.A. Port Darwin, in December; one specimen received from Mr. F. P. Dodd.

UNADILLA TRISSOMITA, *n. sp.*

τρισσομιτος, with three threads.

♂ ♀ 16-18 mm. Head and thorax purple-reddish mixed with whitish; face ochreous-whitish. Palpi reddish-fuscous; base, extreme apex, and most of internal surface whitish. Antennæ and abdomen ochreous-whitish. Legs ochreous-whitish; tarsi fuscous with whitish annulations. Forewings narrow-elongate, apex rectangular, termen rounded, slightly oblique; purple-reddish mixed with fuscous; three white longitudinal streaks; first broad from $\frac{1}{3}$ costa to costa again at apex; second rather above middle, slender and interrupted, from near base, not quite reaching termen; third along fold, similar, from near base to beyond middle; a dark fuscous terminal line; cilia purple-reddish, apices partly fuscous. Hindwings whitish, tinged with grey towards termen; cilia whitish.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October and May; two specimens received from Mr. F. P. Dodd.

UNADILLA ATECMARTA, *n. sp.*

ἀτεκμαρτος, obscure.

♀ 21 mm. Head, thorax, and abdomen fuscous-whitish. Palpi fuscous. Antennæ whitish. Legs whitish irrorated with fuscous. Forewings narrow-elongate, posteriorly dilated, costa moderately arched, apex rounded, termen obliquely rounded; whitish irrorated with fuscous; an obscure externally oblique fuscous line in middle of disc; a fuscous subcostal dot at $\frac{3}{4}$; a fine fuscous obliquely transverse line parallel to termen at $\frac{7}{8}$; an obscure interrupted fuscous terminal line; cilia pale-fuscous irrorated with whitish. Hindwings grey, thinly scaled; cilia whitish with a grey sub-basal line.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October; one specimen from Mr. F. P. Dodd.

GEN. MESEINIADIA.

Tongue well-developed. Palpi recurved, ascending, reaching vertex, apex acute; third joint in ♂ with a short, basal, anterior tuft. Antennal ciliations of ♂ extremely short. Forewings with 2 and 3 long stalked, 4 and 5 long-stalked, 8, 9, 10 stalked. Hindwings with 2 from near angle, 3 and 4 stalked, 7 anastomosing strongly with 8.

Related to the following genus, but peculiar in the stalking of 2 and 3 of the forewings.

MESEINIADIA INFRACTALIS.

Nephopteryx infractalis, Wlk., Cat. Brit. Mus. xxx., p. 958.

♂ ♀ 12-13 mm. Head brown-whitish; face in ♂ dark fuscous. Palpi whitish; outer surface of third joint fuscous. Antennæ, thorax, and abdomen brown-whitish. Legs ochreous-whitish with some fuscous irroration. Forewings narrow, costa straight, gently arched beyond middle, apex rounded, termen obliquely rounded; brown-whitish irrorated and suffused with brown; markings dark-fuscous; a dot on base of costa; costal edge to $\frac{1}{3}$ dark-fuscous; an interrupted median streak, more or less marked, ending in terminal suffusion; a short streak on base of dorsum; an oblique streak from $\frac{1}{3}$ costa, bent in disc to become longitudinal, and ending in terminal suffusion; dorsal edge more or less dark-fuscous; a large tornal dark-fuscous suffusion extending nearly to apex; cilia grey. Hindwings whitish more or less suffused with grey; cilia grey.

A very obscure little species easily recognised by structural characters.

N.Q. Kuranda, near Cairns, in October and May; Innisfail in November; also from Borneo.

GEN. ENCRYPHODES, NOV.

ἐγκρυφωδμς, hidden.

Tongue well-developed. Palpi ascending, appressed to frons, reaching vertex, tolerably acute. Forewings with 4 and 5 stalked, 8, 9, 10 stalked. Hindwings with 2 from before angle of cell, 3 and 4 stalked, 5 absent, 7 anastomising strongly with 8.

ENCRYPHODES ÆNICTOPA, *n. sp.*

αἰνικτωπος, obscure.

♂ 15 mm. Head, palpi, thorax, and abdomen ochreous-whitish. Antennæ pale-fuscous; in ♂ thickened, ciliations imperceptible. Legs ochreous-whitish. Forewings moderate, costa gently arched, apex rounded, termen obliquely rounded; ochreous-whitish suffused with fuscous; a straight oblique pale line from $\frac{2}{5}$ costa to $\frac{3}{5}$ dorsum, preceded by a fuscous suffusion; a slightly sinuate pale line from $\frac{5}{6}$ costa to $\frac{5}{6}$ dorsum:; cilia ochreous-whitish, apices fuscous. Hindwings grey; cilia pale-grey, bases ochreous-whitish.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October; one specimen received from Mr. F. P. Dodd.

EUZOPHERA STICHOSEMA, *n. sp.*

στιχοσημος, marked with lines.

♂ ♀ 11-12 mm. Head fuscous-whitish; face ochreous-whitish. Palpi with a small anterior tuft of scales on second joint towards its apex; fuscous-whitish mixed with fuscous. Antennæ whitish; in ♂ thickened, minutely ciliated, and with fine dark-fuscous annulations. Legs whitish mixed with fuscous; posterior pair mostly whitish; tarsi fuscous annulated with whitish. Forewings dilated posteriorly, costa straight to middle, then strongly arched, apex rounded, termen obliquely rounded; brown-whitish with some fuscous irroration; two dark-fuscous transverse lines; first from mid-costa to mid-dorsum, outwardly curved; second subterminal, straight; cilia grey. Hindwings whitish, becoming grey towards apex; cilia whitish, at apex grey.

Type in Coll., Turner.

Q. Brisbane, in August and October; Rosewood in March; three specimens.

HYPHANTIDIUM SERICARIUM.

Hyphantidium sericarium, Scott, P.Z.S., 1859, p. 207, Pl. 61.
Euzophera microdoxa, Meyr., P.L.S., N.S.W., 1880, p. 231.

Sir Geo. Hampson kindly identified one of my Port Darwin examples, and these correspond closely with Mr.

Meyrick's excellent description. It is the type species of the genus.

N.A. Port Darwin; Q. Duaringa; N.S.W., Wollombi; T., Launceston.

HYPHANTIDIUM ATERPES.

ἀτερπης, unpleasing.

♂ ♀ 11-12 mm. Head and thorax brown-whitish. Palpi brown-whitish with some fuscous irroration. Antennæ brown-whitish; in ♂ thickened and slightly serrate, ciliations imperceptible. Legs brown-whitish mixed with fuscous. Forewings dilated posteriorly, costa gently arched, apex rounded, termen obliquely rounded; brown-whitish irrorated with fuscous; markings dark-fuscous; a dot beneath mid-costa, a second in disc slightly below and posterior to this, and a third above mid-dorsum; two dots placed transversely in disc at $\frac{2}{3}$, the lower larger; a finely dentate line from before apex to before tornus, and another more acutely dentate from apex to tornus; cilia brown-whitish. Hindwings grey-whitish; cilia whitish.

Type in Coll., Turner.

N.A. Port Darwin, in October and January; two specimens received from Mr. F. P. Dodd.

HYPHANTIDIUM SEMIFICTILE, *n. sp.*

Semifictilis, half made of clay.

♂ 14 mm. Head ochreous-whitish. Palpi grey-whitish. Antennæ grey; ciliations in ♂ $\frac{1}{4}$. Thorax grey. Abdomen pale-ochreous. Legs grey; posterior pair ochreous-whitish, tarsi on outer surface grey. Forewings moderate, costa gently arched, apex rounded, termen obliquely rounded; grey, finely irrorated with fuscous; cilia grey. Hindwings brownish-ochreous; at apex grey; cilia pale-ochreous, at apex grey.

Type in Coll., Turner.

Q. Stradbroke Island, in September; one specimen.

TYLOCHARES EREMONOMA, *n. sp.*

ἐρημονομος, dwelling in the desert.

♀ 19 mm. Head whitish-brown. Palpi rather long ($2\frac{1}{2}$), obliquely ascending, not appressed to frons, second joint very long, terminal joint very short $\frac{1}{6}$, obtuse; whitish

terminal joint and apex of second joint on external surface brownish. Antennæ brown. Thorax brown. Abdomen ochreous-whitish. Legs [anterior and middle pairs broken], posterior pair whitish. Forewings narrow-elongate, slightly dilated posteriorly, costa nearly straight, apex rounded, termen obliquely rounded; reddish-brown; a very ill-defined broad costal streak from near base to near apex, white sparsely irrorated with reddish-brown; cilia whitish-brown. Hindwings grey:; cilia whitish.

Type in Coll., Turner.

Q. Adavale, in May; one specimen.

TYLOCHARES HEMICHIONEA, *n. sp.*

ἡμιχιονεος, half-snowy.

♂ 17 mm. Head, palpi, and thorax fuscous. Antennæ fuscous; in ♂ thickened and minutely ciliated. Abdomen brownish-grey, base of dorsum ochreous-tinged. Legs white with scanty brown irroration; apical half of anterior and middle coxæ, anterior and middle femora except middle, anterior and middle tibiæ except apex and one or two white dots, and all tarsi, fuscous. Forewings narrow-elongate, costa gently arched, apex rounded, termen obliquely rounded; brown-fuscous with purple reflections; a broad white streak from costa at $\frac{1}{4}$ to apex, its dorsal edge ill-defined; costal edge in middle $\frac{1}{4}$ brown-fuscous; cilia fuscous, bases whitish. Hindwings grey; cilia grey, paler towards tornus, bases whitish.

Similar to the preceding but with very different palpi, the terminal joint being well developed ($\frac{2}{3}$) and rather acute.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October; one specimen received from Mr. F. P. Dodd.

TRISSONCA ODONTOSEMA, *n. sp.*

ὀδοντοσημος, tooth-marked.

♂ ♀ 20-22 mm. Head brownish; face whitish. Palpi whitish with brown irroration. Antennæ pale-fuscous; in ♂ much thickened with minute ciliations. Abdomen pale ochreous-brown. Legs whitish irrorated, except posterior pair with fuscous; tarsi fuscous with whitish annulations. Forewings elongate-triangular, costa slightly arched,

apex rounded, termen obliquely rounded; whitish densely suffused with fuscous; costal area except basal fourth and apex mostly whitish; a suffused oblique line from $\frac{1}{3}$ costa to mid-dorsum; a pair of median discal dots placed transversely, sometimes obsolete; a finely dentate transverse line at $\frac{5}{6}$; a terminal series of fuscous dots; cilia fuscous-whitish. Hindwings with cell $\frac{1}{2}$ or rather less, 2 from well before angle 3 and 4 separate but closely approximated at origin; fuscous-whitish or fuscous; cilia fuscous-whitish.

Type in Coll., Turner.

N.Q. Kuranda near Cairns, in August, October and April; five specimens received from Mr. F. P. Dodd.

Phycita olivalis.

Phycita olivalis, Hmps., Moths. Ind., iv., p. 92.

N.Q. Kuranda, near Cairns, in August, December and April; five specimens received from Mr. F. P. Dodd.

Besides the following I have many unnamed species of *Phycita* and *Nephopteryx*, which I think it wiser not to name at present.

Phycita cryptadia, *n. sp.*

κρυπταδιος, hidden.

♀ 25 mm. Head and thorax dark brownish-grey. Palpi brownish-grey, second joint irrorated with whitish. Antennæ whitish-grey. Abdomen grey tinged with brown. Legs fuscous with obscure whitish irroration and annulations. Forewings elongate, posteriorly dilated, costa moderately arched, apex rounded, termen obliquely rounded; grey tinged with brown and mixed with whitish; a whitish transverse line from mid-costa to dorsum beyond middle, indented inwards above middle and again above dorsum; beyond this are two rather large brown suffused spots placed transversely; a finely dentate whitish line from costa at $\frac{5}{6}$ obliquely outwards, then bent parallel to termen, and ending in dorsum near tornus; a terminal series of dark-fuscous dots; cilia grey with whitish points. Hindwings thinly scaled; pale-grey, darker towards apex; cilia whitish with a grey sub-basal line.

Type in Coll., Turner. My second example is in the British Museum.

N.Q. Kuranda, near Cairns, in October; two specimens received from Mr. F. P. Dodd.

CRYPTOBLABES ALPHITIAS, *n. sp.*

ἄλφιτα, barley-meal.

♀ 12 mm. Head, palpi, antennæ, thorax, and abdomen grey. Legs white irrorated with grey; tarsi grey with white annulations. Forewings narrow, somewhat dilated posteriorly, apex rounded, termen obliquely rounded; fuscous-grey, towards costa broadly irrorated with white; a fuscous line from costa before middle to dorsum beyond middle, interrupted beneath costa; two fuscous discal dots at $\frac{2}{3}$, placed transversely, sometimes connected; a whitish line at $\frac{5}{6}$ parallel to termen, preceded by a fuscous line obsolete towards costa; a terminal series of fuscous dots; cilia pale-grey with white points. Hindwings whitish; veins outlined in grey; cilia whitish.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October; one specimen received from Mr. F. P. Dodd.

CRYPTOBLABES HEMIGYPSA, *n. sp.*

ἡμίγυψος, half-chalky.

♂ ♀ 14-17 mm. Head, palpi, antennæ, and thorax whitish-grey. Abdomen grey towards apex in ♂ whitish. Legs whitish irrorated with grey, and sometimes also with reddish. Forewings narrow-elongate, posteriorly slightly dilated, costa moderately arched, apex rounded, termen obliquely rounded; pale grey, costa half broadly irrorated or suffused with white, sometimes also with some reddish scales; a fuscous sub-costal spot at $\frac{1}{3}$, sometimes indistinct; two fuscous discal dots at $\frac{2}{3}$, placed transversely; an ill-defined fuscous transverse line at $\frac{5}{6}$, parallel to termen, sometimes a similar sub-terminal line; a terminal series of fuscous dots; cilia pale-grey, apices white. Hindwings thinly scaled, whitish; veins and margins outlined with grey; cilia whitish.

Type in Coll., Turner.

Q. Brisbane, in August, September, and November; four specimens.

GEN. MACROCHILOTA, NOV.

μακροχειλοτος, long-lipped.

Frons oblique and flat. Tongue present. Palpi very long, porrect densely hairy above and beneath. Maxillary palpi very short, filiform. Tibiæ with outer spurs not exceeding $\frac{1}{2}$ length of inner spurs. Forewings with 4 and 5 stalked, 8 and 9 long stalked, 10 and 11 separate. Hindwings with cell about $\frac{1}{2}$, 3 and 4 stalked, 5 absent, 7 anastomosing with 8.

MACROCHILOTA ARÆOSTICHA, *n. sp.*

ἀραιοστιχος, narrow-lined.

♀ 23-26 mm. Head pale ochreous-grey. Palpi in ♀ 7; pale-fuscous, inner surface whitish. Antennæ and thorax pale ochreous-grey. Abdomen grey. Legs whitish-grey; anterior pair grey. Forewings elongate, costa gently arched, apex rounded, termen obliquely rounded; pale ochreous-grey; three white lines partly edged with fuscous, arising from a white sub-costal basal spot; first line costal, leaving costal edge narrowly grey, running into second line before middle; second line sub-costal, nearly approximated to first, ending on costa shortly before apex; third line median, running along lower edge of cell, and ending on termen above middle; sometimes posterior edge of cell and terminal veins are partly outlined with fuscous; cilia pale-grey with white points. Hindwings whitish suffused with grey towards apex and termen, sometimes wholly grey; cilia grey-whitish.

Type in Coll., Turner.

N.S.W. Ben Lomond (4,500 ft.), in January: three specimens, of which one is in the British Museum.

SUB-FAM. GALLERIANÆ.

HETEROMICTA LEPTOCHLORA, *n. sp.*

λεπτοχλωρος, slightly green.

♂ 24 mm. Head white. Palpi fuscous. Antennæ white with dark fuscous annulations; in ♂ minutely ciliated. Thorax white with some faint green suffusion. Abdomen ochreous-whitish. Legs whitish irrorated with grey and annulated with dark fuscous. Forewings rather elongate, costa moderately arched, apex rounded, termen

rounded, slightly oblique; whitish suffused with pale-green and irrorated with grey; a transverse whitish line at $\frac{1}{3}$ forming three large dentations; a blackish oblique discal mark at middle preceded by a blackish dot; a finely dentate whitish line edged anteriorly by a fine grey line, from $\frac{2}{3}$ costa outwards, then bent in disc, and ending on $\frac{4}{5}$ termen; beyond this is a greyish suffusion; a terminal series of dark-fuscous dots; cilia grey mixed with whitish. Hindwings grey, paler towards base; cilia whitish with a grey basal line.

Type in Coll., Turner.

N.Q. Herberton in January; one specimen received from Mr. F. P. Dodd.

DOLOESSA VIRIDIS.

Viridis, Zel., Isis, 1848, p. 860.

Thagora figurana, Wlk., Brit. Mus. Cat. xxvii., p. 205, Hmps., Ill. Het. ix. Pl. 157., f. 8. Moths Ind., iv., p. 5.

N.Q. Cairns. Also from Java and Ceylon.

MELIPHORA MYRMECOPHILA, *n. sp.*

μυρμηκοφιλος, ant loving.

♀ 22 mm. Head, palpi, antennæ, thorax, and abdomen fuscous. Legs fuscous irrorated and annulated with whitish. Forewings elongate-oval, costa strongly arched, apex rounded, termen very obliquely rounded; fuscous with some dark-fuscous irroration especially towards base; some dark-fuscous scales on termen; cilia fuscous. Hindwings with termen sinuate; fuscous, paler towards base; cilia fuscous.

Type in Coll., Turner.

N.Q. Townsville, in October; one specimen received from Mr. F. P. Dodd, who found the rather hairy and somewhat smoky larvæ in the closed galleries of a tree ant (*Crematogaster s.p.*), where they pupate, the small oval cocoons being peppered with small fragments of bark.

GEN. ACARA.

Acara, Wlk., Brit. Mus. Cat. xxvii., p. 198, Hmps., Moths Ind., iv., p. 7.

Palpi clothed with long hairs. Antennæ of ♂ minutely ciliated, with a tuft of long hairs from basal joint. Forewings with apex acute and produced; lower angle of cell more or less produced, 2 from middle, 3 from $\frac{3}{4}$, 4 and 5

connate or separate, 7, 8, 9 stalked, 10 and 11 separate. Hindwings with 4 and 5 stalked, 6 and 7 stalked, 7 anastomosing with 8.

ACARA PSOLOPASTA, *n. sp.*

ψολοπαστος, sprinkled with soot.

♂ 36 mm. Head, palpi, antennæ, thorax, and abdomen and legs ochreous-whitish. Forewings elongate, costa straight, before apex incurved, apex produced, bent costally, and acute, termen scarcely oblique, rounded beneath; 7 from 8 before 9; ochreous-whitish, suffused with pale ochreous-grey, and sparsely irrorated with dark-fuscous; cilia pale ochreous-grey. Hindwings with termen rounded; ochreous-whitish; cilia ochreous whitish.

Type in Coll., Turner.

N.Q. Atherton; one specimen.

SUB.-FAM. CRAMBINÆ.

DIPTYCHOPHORA LEUCOGRAMMA, *n. sp.*

λευκογραμμος, inscribed with white.

♂ 11 mm. Head whitish-ochreous. Palpi whitish-ochreous with pale-fuscous hairs. Antennæ whitish; ciliations in ♂ very short ($\frac{1}{3}$). Thorax whitish-ochreous. Abdomen pale-fuscous, at base whitish-ochreous, tuft whitish. Legs whitish. Forewings triangular, costa nearly straight, apex rounded, termen oblique, nearly straight, incised beneath apex; fuscous mixed with whitish; a patch on base of dorsum and terminal half of disc, especially on veins, suffused with brownish-ochreous; a median white line from base to $\frac{1}{4}$ where in divides into two limbs forming a Y, costal limb ending beneath $\frac{1}{3}$ costa, dorsal limb at mid-dorsum; a white line from $\frac{2}{3}$ costa curved outwards and then parallel to termen and ending in $\frac{2}{3}$ dorsum; an oblique white subapical costal streak nearly to termen; a few blackish scales on lower part of termen; cilia brownish-ochreous, a leaden-fuscous sub-basal line not reaching tornus, apices fuscous at apex of wing, on costa before apex white. Hindwings with termen sinuate; ochreous-whitish; cilia ochreous-whitish, a pale-grey basal line on apex of wing.

Type in Coll., Turner.

Q. Bribie Island, near Caloundra, Moreton Bay, in September; one specimen.

TALIS POLYARGYRA, *n. sp.*

πολυαργυρος, rich in silver.

♂ 24-28 mm. Head pale brownish-ochreous. Palpi very long (8); pale-fuscous. Antennæ grey; in ♂ serrate with short ciliations ($\frac{1}{2}$). Thorax brownish-ochreous, with a white posterior spot. Abdomen pale-ochreous. Legs pale-fuscous; posterior pair whitish-ochreous. Forewings moderately elongate, costa gently arched, apex round-pointed, termen sinuate, slightly oblique; brownish-ochreous; markings silvery-white; a whitish costal streak more or less defined; a broad median streak from base to end of cell edged with a few fuscous scales; a fine streak along vein 2; five short broad interneural streaks beyond cell; veins beyond cell more or less outlined with fuscous; a subterminal line from beneath apex nearly to tornus, interrupted by fuscous lines on veins; cilia whitish with silvery lustre, a fine fuscous line at $\frac{1}{3}$. Hindwings with termen slightly sinuate; pale-ochreous; cilia whitish-ochreous.

Type in Coll., Turner.

N.S.W., Glen Innes, in March; four specimens.

SUB-FAM. PYRALINÆ.

GEN. MICROCYTTARA, NOV.

μικροκυτταρος, small-celled.

Frons flat. Tongue well-developed. Palpi moderate, porrect; second joint long, slightly ascending; terminal joint short, stout, obtuse, slightly bent downwards. Thorax with a small posterior crest. Legs with outer spurs less than $\frac{1}{2}$ as long as inner spurs. Forewings elongate; without raised scales; discocellulars very strongly curved inwards, 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 approximated at base from angle, 6 from upper angle connate with 7, 8, 9, which are stalked, 10 and 11 separate. Hindwings considerably broader than forewings; cell extremely short ($\frac{1}{5}$), discocellulars very strongly bowed inwards, strongly produced at both angles, 3, 4 and 5 stalked, 7 anastomosing with 8 for some distance.

This curious genus is not closely related to any known to me, but I think it may be regarded as a development of *Bostra* with peculiarly exaggerated neural characters.

MICROCYTTARA EUMECES, *n. sp.*

εὐμήκης, of good length.

♀ 42 mm. Head, palpi, and antennæ brownish-grey. Thorax brownish-grey, a large posterior spot and a small spot on base of each patagium fuscous. Abdomen ochreous-whitish irrorated with pale-fuscous, slightly tinged with ochreous on base of dorsum. Legs ochreous-whitish; femora, tibiæ, and first tarsal joints with oblique dark-fuscous rings. Forewings elongate-oval, costa strongly arched, apex rounded, termen obliquely rounded; brownish-grey with slight fuscous and reddish-brown irroration; markings fuscous; an oblique line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum, indented inwards on fold; a median sub-costal spot; a sharply dentate line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, bent outwards in disc; a terminal series of dots; cilia ochreous-whitish with some fuscous irroration. Hindwings slightly sinuate beneath apex; ochreous-whitish; a fine interrupted pale-fuscous terminal line from apex for some distance; cilia ochreous-whitish.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in October; one specimen received from Mr. F. P. Dodd.

GEN. ODONTOPASCHIA.

Odontopaschia, Hmps.

Frons with an anterior tuft. Tongue present. Palpi long, porrect; second joint very long, with a short tuft at apex; terminal joint short, slender, smooth. Antennæ of ♂ unknown. Forewings with tufts of raised scales; 4 and 5 stalked, 7 absent, 8, 9, 10 stalked, 11 separate. Hindwings with 3 and 4 separate, 5 absent, 7 anastomosing with 8.

Type *O. virescens*, Hmps. from India.

ODONTOPASCHIA ECNOMIA, *n. sp.*

ἐκνόμιος, unusual.

♀ 20 mm. Head and thorax brown-whitish mixed with dark-fuscous. Palpi 5; brown-whitish, outer aspect of second joint dark-fuscous. Antennæ brown-whitish. Abdomen brown-whitish. Legs fuscous; tarsi annulated with whitish. Forewings triangular, costa scarcely arched,

apex round-pointed, termen bowed, oblique; brown-whitish mixed and suffused with fuscous; a tuft of dark-fuscous scales on middle third of dorsal margin; basal part of disc suffused with fuscous; a large raised sub-costal tuft of dark-fuscous scales at $\frac{1}{3}$, and a second smaller beyond middle; a fuscous line from first tuft to $\frac{3}{4}$ dorsum, preceded by a pale line; a fuscous line from $\frac{3}{4}$ costa obliquely outwards, then acutely angled inwards and finely wavy to dorsum before tornus; a dark-fuscous terminal line; cilia brown-whitish with two dark lines. Hindwings with termen rounded, slightly wavy; grey, towards base paler; cilia pale-grey.

Type in Coll., Turner.

N.Q. Kuranda near Cairns, in December; two specimens received from Mr. F. P. Dodd, of which one is in the British Museum.

GEN. SIALOCYTTARA, NOV.

σιαλοκυτταρος, with greasy cell.

Tongue well-developed. Palpi ascending, appressed to frons, much exceeding vertex; posterior aspect of terminal joint and of apex of second joint clothed with long hairs, which in ♂ form dense tufts; second joint in ♂ dilated to receive the brush-like maxillary palpi. Antennæ of ♂ with fascicles of moderately long cilia, no process from basal joint. Thorax with a small post-median crest. Forewings of ♂ with cell on underside covered by modified greasy-looking scales, terminal area of wing abbreviated, and veins short; 7, 8, 9 stalked. Hindwings broad; in ♂ with modified scales along costa beneath; 4 and 5 connate or short-stalked, 7 closely approximated to 8, not anastomosing.

Near *Heterobela*, Turn., but with peculiarly tufted palpi, and in ♂ with modified scale-areas and truncated forewings.

SIALOCYTTARA ERASTA, *n. sp.*

ἐραστος, beloved.

♂ 28 mm. Head and palpi white mixed with dark-green. Antennæ ochreous-whitish; ciliations 2. Thorax white mixed with dark-green and reddish-brown; a central

reddish-brown spot. Abdomen white partly suffused with reddish-brown, with some blackish irroration on sides; tuft pale-ochreous, towards apex fuscous. Legs white mixed with reddish-brown and blackish; tarsi dark-fuscous with white annulations. Forewings triangular, costa straight, apex rounded, termen strongly bowed, slightly oblique; greenish-grey with glossy reflections; a large snow-white spot on base of costa; some blackish and reddish-brown scales on basal part of dorsum; a large dark-green central fascia, its edges very irregular, preceded by a snow-white spot on and beneath costa, and containing some blackish scales near posterior edge above and below middle; this is partly edged and intersected in middle by whitish-ochreous; a dark-green spot surrounded by white on costa at $\frac{4}{5}$; before this is a small similar sub-costal spot edged with whitish-ochreous; a third similar spot on dorsum near tornus; some pale reddish-brown suffusion towards termen; four leaden-fuscous spots on termen beneath apex; cilia fuscous mixed with whitish and reddish-brown. Hindwings pale-reddish; near base becoming ochreous-whitish; cilia whitish, towards apex barred with fuscous.

♀ 30 mm. Head and thorax similar. Palpi ochreous-whitish. Abdomen whitish tinged with green; laterally chiefly dark-fuscous. Forewings more elongate-triangular; a snow-white basal costal spot; base dark green to $\frac{1}{4}$; central area white with dark-green blotches on mid-costa and mid-dorsum; an indistinct dentate transverse line from $\frac{3}{4}$ costa, bent inwards beneath costal blotch and ending on $\frac{3}{4}$ dorsum; terminal area dark-green, becoming fuscous towards termen. Hindwings white; a large fuscous apical blotch continued as a narrow band along termen.

Though very different I think these will prove to be sexes.

Types in Coll., Turner.

N.Q. Kuranda, near Cairns, in July (♂) and December (♀); two specimens received from Mr. F. P. Dodd.

GEN. AXIOCRITA, NOV.

ἀξιόκριτος, worth choosing.

Frons flat. Tongue well-developed. Palpi slender, ascending, very long; second joint very long, much exceeding vertex: terminal joint acute; distal half of second joint and terminal joint with long hairs on posterior surface; second joint in ♂ not dilated. Antennæ in ♂ moderately ciliated, no antennal process. Abdomen with dorsal crests on first two segments. Forewings with raised scale tufts; 4 and 5 separate at origin, 7, 8, 9 stalked, 10 closely approximated to them. Hindwings with 4 and 5 separate, 7 anastomosing with 8.

Allied to the preceding but differing in the neuration of the hindwings, and in the ♂ palpi.

AXIOCRITA CATAPHANES, *n. sp.*

καταφανής, conspicuous.

♂ 25 mm. Head brown, on face mixed with whitish. Palpi very long (6); brown; extreme apex whitish. Antennæ grey; in ♂ dentate, with moderate ciliations (1). Thorax brown with three whitish spots, one posterior, and one on each patagium. Abdomen fuscous; apex brownish; bases of second and third segments whitish. Legs brown-fuscous; base of anterior coxæ white; tarsi with narrow whitish annulations. Forewings triangular, costa gently arched, apex rounded, termen bowed, oblique; fuscous; base, a broad costal streak, a small area in disc, and veins towards termen suffused with dull ochreous-green; six prominent scale-tufts; first near base, white; the remainder fuscous, three sub-costal, and two on median vein; white dots on costa at $\frac{1}{5}$, $\frac{3}{5}$, and $\frac{4}{5}$; a white dot just posterior to basal tuft; a faint, whitish, irregularly dentate line from sub-apical dot to before tornus; beyond this terminal area is paler; cilia whitish barred with pale-fuscous. Hindwings bright orange-yellow; a dark-fuscous terminal band, broad at apex, narrowing to tornus; cilia fuscous.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in September; one specimen received from Mr. F. P. Dodd.

Macalla mniomima, *n. sp.*

μνιομιμος, imitating moss.

♂ ♀ 23-25 mm. Head white with a green spot on crown. Palpi green with a few whitish scales. Antennæ ochreous-whitish; ciliations in ♂ 2; antennal process in ♂ green. Abdomen pale-green mixed with whitish. Legs whitish mixed with green and fuscous; tarsi green-fuscous annulated with whitish. Forewings elongate-triangular, costa slightly arched, apex rounded, termen bowed, slightly oblique; whitish densely suffused with yellow-green which is arranged in confused, broken, dentate or wavy transverse lines; a dark-fuscous median spot at $\frac{1}{3}$; beyond this an incomplete wavy whitish transverse fascia, divided into two by a wavy green line; a dark-fuscous median subcostal spot with a similar spot or suffusion between it and dorsum; sometimes some patchy dark-fuscous suffusion towards termen; cilia whitish with a basal series of yellow-green dots. Hindwings grey; cilia ochreous-whitish.

Type in Coll., Turner.

N.Q. Atherton in February; four specimens. Also in British Museum from New Guinea.

Macalla chlorophœna, *n. sp.*

χλωροφοινος, green and red.

♂ ♀ 35-42 mm. Head, thorax, palpi, and antennæ yellowish-green. Antennal ciliations in ♂ short ($\frac{2}{3}$). Abdomen whitish partly suffused with pale-reddish, with a few fuscous scales. Legs ochreous-whitish. Forewings elongate-triangular, costa gently arched, apex rounded, termen bowed, slightly oblique; whitish densely but patchily suffused with brownish-green; a short transverse linear dark-fuscous discal mark beneath mid-costa; a pale transverse line from $\frac{3}{4}$ costa to $\frac{4}{5}$ dorsum, angulated outwards in middle, and succeeded by a darker shade containing some dark-fuscous scales; an interrupted dark-greenish terminal line; cilia whitish. Hindwings brownish-red; a dark-fuscous terminal band, broadest at apex; cilia pale-reddish.

Type in Coll., Turner.

Q. Mount Tambourine, in December and January; two specimens.

MACALLA PELOSCIA, *n. sp.*

πηλοσκιος, with muddy shade.

♂ 25 mm. Head and thorax whitish mixed with dull-reddish. Palpi greenish with some whitish and towards apex with some dull-reddish scales. Antennæ grey; ciliations in ♂ short (½); antennal processes in ♂ whitish mixed with dull-reddish. Abdomen ochreous-whitish. Legs ochreous-whitish irrorated with dull-reddish; tarsi fuscous with whitish annulations. Forewings triangular, costa gently arched, apex rounded, termen bowed, slightly oblique; whitish mixed with grey and dull-reddish; a darker dorsal shade containing some fuscous scales from ¼ nearly to tornus, extending half across wing; a pale transverse line edged by dark lines at ¼, obsolete towards costa; an obscure darker median discal spot; a whitish mark preceded by a dark mark on costa at ⅔; a darker subterminal shade; a terminal series of fuscous dots best marked towards apex; cilia whitish, with a pale-reddish basal line interrupted by fuscous dots. Hindwings pale-fuscous becoming darker towards termen; cilia as forewings but basal line and dots much paler.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in December; one specimen received from Mr. F. P. Dodd.

EPIPASCHIA POLYSCIA, *n. sp.*

πολυσκιος, very shady.

♂ ♀ 25-28 mm. Head pale-brown; face mixed with fuscous. Palpi pale-brown; second joint with obscure antemedian and subterminal fuscous rings; terminal joint fuscous except apex. Antennæ pale-brown; ciliations in ♂ 1. Thorax pale-brown. Abdomen brown-whitish with some fuscous irroration; dorsum tinged with ochreous. Legs brown mixed with whitish and annulated with fuscous; tarsi fuscous with whitish annulations. Forewings triangular, costa gently arched, apex rounded, termen bowed, oblique; brown-whitish irrorated with brown; markings fuscous; a spot on dorsum near base; a large triangular blotch on costa at ¼; a smaller blotch between this and dorsum; an interrupted line from ⅗ costa to mid-dorsum; a median sub-costal dot preceded by a crest of pale scales;

a line from $\frac{2}{3}$ costa obliquely outwards, bent inwards in disc and ending on $\frac{3}{4}$ dorsum; an ill-defined brown blotch containing some fuscous scales on costa near apex; a brown-fuscous terminal line interrupted on veins; cilia pale-brown, apices whitish. Hindwings fuscous; paler towards base; cilia as forewings but with basal fuscous bars on apical half of termen.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in January; four specimens received from Mr. F. P. Dodd.

EPIPASCHIA CHLOANTHES, *n. sp.*

χλοανθης, green.

♀ 30 mm. Head fuscous-brown, sides of crown green. Palpi 2, third joint $\frac{1}{2}$; dark -fuscous; basal half of second joint green; apices of second and third joints narrowly whitish. Antennæ grey. Thorax green with a few fuscous scales. Abdomen green; a series of median dorsal dots and a few scattered scales brownish and fuscous. Legs whitish irrorated with purple-fuscous and annulated with dark fuscous; external surface of middle tibiæ green. Forewings elongate-triangular, costa gently arched, apex rounded, termen bowed, oblique; bright-green; markings brownish-fuscous; three dark-fuscous costal spots at $\frac{1}{6}$, $\frac{1}{3}$, and $\frac{3}{5}$; less defined spots on dorsum at $\frac{1}{6}$ and $\frac{1}{3}$; a median discal dot with some irroration beneath it; a line from third costal dot obliquely outwards, bent in disc, parallel to termen for a short distance, then bent inwards, and again to end in dorsum at $\frac{2}{3}$; a large dark apical patch; a small patch above tornus; a series of dark-fuscous terminal dots; cilia pale-reddish, apices whitish, barred with fuscous. Hindwings whitish with a reddish tinge; a suffused pale-fuscous terminal band; cilia as forewings but fuscous bars inconspicuous.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in June; one specimen.

ORTHAGA EXVINACEA.

Orthaga exvinacea, Hmps., Ill. Het. viii., p. 127, Pl. 154, f. 9. Mothes. Ind. iv., p. 125.

♂ ♀ 24-28 mm. Head grey-whitish. Palpi grey-whitish; second joint with antemedian and subapical

fuscous rings. Antennæ grey-whitish; ciliations in ♂ 1. Thorax grey-whitish. Abdomen whitish irrorated with fuscous and suffused on dorsum with ochreous. Legs fuscous mixed with whitish; tarsi fuscous with ochreous-whitish annulations. Forewings triangular, costa straight, apex rounded, termen bowed, slightly oblique; grey-whitish with some brownish and fuscous irroration; basal fourth shows more brownish irroration; a transverse fuscous line at $\frac{1}{3}$, often indistinct; a fuscous line from $\frac{2}{3}$ costa obliquely outwards, then bent inwards and either dentate or lost in a dark-fuscous suffusion, then angled inwards, ending on dorsum near tornus; a slight purplish tinge on posterior part of disc; an interrupted fuscous terminal line; cilia pale-brownish barred with fuscous, apices whitish. Hindwings fuscous-whitish; darker towards termen; cilia as forewings.

Sir Geo. Hampson tells me that mine agree with Indian and Ceylon specimens.

N.A. Port Darwin, in October and November; four specimens received from Mr. F. P. Dodd.

ORTHAGA AMPHIMELAS, *n. sp.*

ἀμφιμελας, black all round.

♂ 24 mm. Head grey. Palpi with second joint dilated at apex, terminal joint very short, stout, obtuse; dark-fuscous. Antennæ fuscous; ciliations in ♂ 1. Thorax blackish. Abdomen grey-whitish densely irrorated with dark-fuscous. Legs dark-fuscous mixed, and tarsi annulated, with fuscous. Forewings elongate-triangular, costa straight, apex rounded, termen bowed, slightly oblique; dark-fuscous; a broad whitish suffusion on middle third of costa; markings blackish; an indistinct transverse line at $\frac{1}{4}$; a dot beneath mid-costa; a line from $\frac{2}{3}$ costa obliquely outwards nearly to mid-termen, there forming a rounded projection, angulated inwards above dorsum, which it joins near tornus; a few white scales near termen; cilia fuscous, bases barred with brownish, a few whitish points on apices. Hindwings fuscous-whitish; darker towards termen; cilia white with a fuscous basal line.

The form of the postmedian line of forewings is distinctive. In the palpi this species agrees with the preceding.

Type in Coll., Turner.

N.A. Port Darwin, in December ; one specimen received from Mr. F. P. Dodd.

ORTHAGA BRYOMIMA, *n. sp.*

βρυομιμος, like moss.

♂ 23 mm. Head, thorax, and palpi green. Antennæ grey ; ciliations in ♂ 1. Abdomen whitish mixed with dark-fuscous. Legs greenish ; posterior pair mostly whitish ; tarsi annulated with dark-fuscous. Forewings triangular, costa moderately arched, apex rounded, termen bowed, oblique ; green mixed with whitish-green and with some blackish irroration ; first line indistinct, represented by some confused blackish irroration ; a median subcostal blackish discal tuft of raised scales ; second line from $\frac{2}{3}$ costa, green, traversing a whitish-green blotch obliquely outwards, then curved inwards and ending on dorsum at $\frac{1}{3}$; above dorsum it is preceded by a blackish blotch with suffused edges ; an interrupted dark-fuscous terminal line ; cilia very pale reddish barred with dark-fuscous. Hindwings fuscous, becoming whitish towards base ; cilia as forewings.

Type in Coll., Turner.

Q. Montville (1500 ft.), on Blackall Range, near Nambour, in October ; one specimen.

GEN. ENCHESPHORA, NOV.

ἐγχεσφορος, spear-bearing.

Tongue well-developed. Palpi moderate, porrect ; second joint slightly ascending, rough-haired above towards apex ; terminal joint short, broad, obtuse, down-curved Maxillary palpi broadly dilated at apex. Forewings with 4 and 5 approximated for a short distance, 7, 8, 9, stalked, 10 and 11 separate but approximated. Hindwings with 4 and 5 approximated, 7 anastomosing shortly with 8.

The characters of the ♂ are not known. In other respects, the genus is allied to Doddiana, but differs in the more normal neuration.

ENCHESPHORA POLIOPHANES, *n. sp.*

πολιοφανης, of grey appearance.

♀ 33 mm. Head, thorax and antennæ whitish-grey Face and palpi fuscous. Abdomen grey with a series of

large dark-fuscous median dorsal spots. Legs fuscous; tarsi annulated with ochreous-whitish. Forewings elongate-triangular, costa straight for $\frac{2}{3}$, then gently arched, apex rounded, termen slightly bowed, oblique; whitish-grey, with some dark-fuscous markings and irroration; an obliquely transverse bar from dorsum near base, not reaching costa; a median subcostal dot; a large apical blotch produced along termen ending above tornus in a small terminal enlargement; a terminal series of dark-fuscous spots; cilia whitish-grey. Hindwings fuscous; paler towards base and suffused with pale-reddish towards dorsum; a short pale line parallel to termen beneath middle; cilia whitish with a pale-fuscous sub-basal line.

Type in Coll., Turner.

N.A. Port Darwin, in December; one specimen received from Mr. F. P. Dodd.

Sub-Fam. PYRAUSTINÆ.

Gen. AUCHMOPHOBA, nov.

αὐχμοφοβος, fearing drought.

Frons flat. Tongue obsolete. Palpi rather long; second joint porrect, with a dense tuft of long hairs beneath; terminal joint erect, very slender, acute. Maxillary palpi dilated. Antennæ of ♂ simple, minutely ciliated. Legs long and slender; inner spurs longer than outer. Forewings with 5 absent (coincident with 4), 10 separate. Hindwings with 4 and 5 stalked, 7 anastomosing with 8.

Perhaps nearest *Nannomorpha*, Turn., but there are important differences both in the palpi and neuration.

Auchmophoba tynnuta, *n. sp.*

τυννουτος, so little.

♂ 10-11 mm. Head fuscous mixed with whitish; face whitish. Palpi whitish; tuft on second joint partly fuscous. Antennæ whitish annulated with fuscous; ciliations in ♂ $\frac{1}{2}$. Thorax fuscous mixed with whitish. Abdomen fuscous annulated with whitish. Legs fuscous; posterior pair, except tarsi, whitish. Forewings elongate-triangular, costa rather strongly arched, apex rounded, termen excavated in middle; fuscous mixed with whitish; a transverse line at $\frac{1}{6}$, dentate beneath costa; four pairs of short white streaks from costa, first strongly outwardly

oblique at $\frac{1}{3}$, second less oblique at middle, third transverse at $\frac{3}{4}$, fourth transverse sub-apical; a fuscous subterminal line; cilia whitish, bases and apices fuscous. Hindwings with termen indented at $\frac{1}{3}$ from apex; whitish; a fuscous suffusion on dorsal part of disc before middle, a broad terminal suffusion, and a small suffusion on tornus; cilia as forewings.

Type in Coll., Turner.

Q. Stradbroke Island, in August; six specimens, taken in a swamp at dusk.

AGROTERA GLYCYPHANES, *n. sp.*

γλυκυφανης, of sweet appearance.

♀ 22 mm. Head pale-yellow with two posterior orange spots; face with three orange dots, one on upper and two on lower edge. Palpi pale-yellow with four orange bars on outer surface, the last apical. Antennæ pale-brown; basal joint pale-yellow with an orange dot at apex. Thorax pale-yellow reticulated with orange. Abdomen whitish-ochreous, dorsum of basal segments barred and of apical segments suffused with orange. Legs whitish; anterior and middle tibiæ suffused with orange; anterior tarsi white except two apical segments which are dark-fuscous. Forewings triangular, costa straight for $\frac{2}{3}$, then strongly arched, apex rounded, termen slightly bowed, oblique; pale-brown with a purple gloss; basal third pale-yellow reticulated with orange, bounded by a crenate orange line; a large round pale-yellow spot beneath costa at $\frac{2}{3}$, edged and irrorated with orange; a similar but much smaller spot beneath this; a pale-orange streak along costa from $\frac{1}{3}$ to apex; a fine fuscous line from $\frac{2}{3}$ costa obliquely outwards then bent to form a quadrangular projection, bent again to beneath second spot, thence to $\frac{3}{4}$ dorsum; an interrupted fuscous terminal line; cilia whitish with a brown sub-basal line. Hindwing with termen slightly sinuate; as forewings; but basal patch defined only towards dorsum; no subcostal spots; postmedian line edged externally with orange, and with three confluent yellow spots on dorsal extremity.

Type in Coll., Turner.

N.A. Port Darwin, in January; one specimen received from Mr. F. P. Dodd.

DICHOCROCIS XANTHIAS, *n. sp.*

ξανθος, yellow.

♀ 27 mm. Head, palpi, antennæ, and thorax ochreous. Abdomen ochreous; apices of segments and underside white. Legs whitish-ochreous; posterior pair white. Forewings triangular, costa straight for $\frac{3}{4}$, then strongly arched, apex rounded, termen bowed, oblique; yellow; basal $\frac{1}{4}$ ochreous; markings pale-fuscous; an irregularly dentate transverse line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum limiting basal ochreous patch; a large transversely oval discal spot beneath mid-costa; a broad fascia from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, attenuated at each end; a more suffused terminal band connected with preceding in middle; cilia ochreous, apices whitish. Hindwings with termen slightly sinuate; whitish-yellow; an indistinct pale-fuscous transverse median discal mark at $\frac{2}{3}$, a terminal band from apex narrowing to a point at mid-termen; cilia as forewings.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in March; two specimens received from Mr. F. P. Dodd, of which one is in the British Museum.

DICHOCROCIS LEPTOPHAËS. *n sp*

λεπτοφαης, slightly shining.

♀ 28 mm. Head, palpi, and antennæ fuscous-whitish. Thorax pale-fuscous with slight purple lustre. Abdomen pale-fuscous; apices of segments and underside whitish. Legs white; anterior femora and tibiæ and basal part of middle tibiæ grey. Forewings triangular, costa straight for $\frac{2}{3}$, then strongly arched, apex rounded, termen bowed, oblique; pale-fuscous with slight purple lustre; a roundish whitish spot beneath origin of vein 2, and another in end of cell beneath mid-costa; a suffused whitish spot on mid-costa close to preceding; a small whitish spot in disc beneath $\frac{3}{4}$ costa; cilia whitish interrupted with fuscous. Hindwings fuscous-whitish with slight purple lustre; cilia as forewings.

Type in Coll., Turner.

Q. Stradbroke Island ,in February; one specimen unfortunately in poor condition taken among tropical scrub.

Gen. GLYCYTHYMA.

This genus (Tr. R.S.S.A., 1908, p. 91) must be dropped. The type, *chrysorycta*, Meyr., has the ♂ antennæ formed just as in *rhœonalis* the type of *Nacoleia*. The other species, *thymedes*, is a synonym of *leonina*, Butl.

Nacoleia syngenica, *n. sp.*

συγγενικος, akin.

♀ 23 mm. Head and antennæ brown-whitish. Palpi fuscous; under-surface white except towards apex. Thorax pale-brown. Abdomen pale-brown, with dark-fuscous lateral lines; apices of segments and underside white. Legs whitish; tarsi brown-whitish; anterior tibiæ fuscous except at apex; middle femora with a fuscous blotch on inner side beyond middle. Forewings elongate-triangular, costa straight for ⅔, then arched, apex tolerably acute, termen slightly bowed, oblique; pale-brown; a squarish white spot in disc before middle, slightly biconcave; lines blackish; first from ¼ costa to ⅓ dorsum, slightly curved outwards; second finely dentate, from ¾ costa towards tornus, before reaching it bent inwards to beneath end of cell, then bent again and ending on ⅔ dorsum; an interrupted terminal line; cilia fuscous, bases barred with whitish, above tornus wholly whitish. Hindwings fuscous, towards base whitish; lines dark-fuscous; first from ⅓ costa to ¾ dorsum, outwardly curved; second dentate, from ⅔ costa, bent rather outwards in disc, obselete towards dorsum; cilia as forewings but more whitish towards tornus.

Best distinguished from *rhœonalis* by the single whitish spot on forewing.

N.Q. Atherton, in June; one specimen.

Nacoleia melanauges, *n. sp.*

μελαναυγης, dark.

♀ 20 mm. Head ochreous-whitish mixed with fuscous; face fuscous. Palpi fuscous; base beneath whitish. Antennæ fuscous, towards base whitish. Thorax and abdomen dark-fuscous. Legs ochreous-whitish. Forewings elongate-triangular, costa with basal ¾ slightly concave, strongly arched before apex, apex rounded, termen rather strongly bowed, oblique; dark-fuscous; lines but

slightly darker and very obscure ; a transverse line at $\frac{1}{3}$; a whitish subcostal dot about $\frac{1}{3}$; postmedian line from $\frac{4}{5}$ costa, wavy, bent above tornus to below end of cell, and again to $\frac{2}{3}$ dorsum ; edged posteriorly by a few whitish dots, and on costa by a short whitish streak ; cilia dark-fuscous. Hindwings rather narrow and elongate, termen sinuate ; dark-fuscous, towards base mixed with whitish ; first line distinct, curved, from $\frac{1}{3}$ costa to $\frac{3}{4}$ dorsum ; second line obsolete ; cilia dark-fuscous, between tornus and mid-termen whitish except bases.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in June ; one specimen.

TYSPANODES PHÆOSTICHA, *n. sp.*

φαιοστιχος, dusky-lined.

♂ ♀ 25-28 mm. Head ochreous ; face whitish-ochreous. Palpi fuscous ; beneath whitish-ochreous except towards apex. Antennæ whitish-grey; ciliations in ♂ 1. Thorax ochreous ; tegulæ and bases of patagia wholly or partly dark-fuscous. Abdomen ochreous, dorsum except at base suffused with fuscous. Legs ochreous-whitish ; anterior pair except tarsi fuscous ; all tarsi annulated with fuscous. Forewings oval-triangular, costa rather strongly arched, apex obtusely rounded, termen bowed, oblique ; reddish-ochreous, with numerous fuscous inter-neural streaks variably developed ; a whitish patch on termen from below middle to tornus ; the fuscous streaks do not quite reach termen ; cilia fuscous, on tornal patch whitish. Hindwings ochreous-yellow ; a dark-fuscous apical blotch, prolonged as a band more or less along termen, sometimes not reaching tornus ; cilia on apical half of wing fuscous, beneath this whitish, on tornus and dorsum ochreous-yellow.

Ab. Forewings wholly suffused with dark-fuscous.

Type in Coll., Turner.

N.Q. Evelyn Scrub, near Herberton, in December.

Q. Eumundi, near Nambour, in October. Five specimens.

SYLEPTA SYMPHONODES, *n. sp.*

σνμφωνωδης, harmonious.

♂ ♀ 28 mm. Head, thorax, palpi, and antennæ yellow. Antennal ciliations in ♂ 1. Abdomen yellow; a pair of basal fuscous dots on dorsum of third segment; sides and underside whitish. Legs whitish; anterior pair tinged with ochreous; apex of anterior tibiæ fuscous. Forewings triangular, costa straight for $\frac{3}{4}$, then strongly arched, apex rectangular, termen slightly bowed, oblique; yellow; markings fuscous; a sub-basal dorsal dot; an outwardly curved line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; an outwardly crescentic discal mark beneath mid-costa; a line from $\frac{3}{4}$ costa, bent outwards in disc and with three dentations, then bent inwards to beneath discal mark, again curved, with a small posterior tooth above dorsum, ending on $\frac{3}{4}$ dorsum; traces of a pale-fuscous terminal line best marked near tornus; cilia pale-yellow. Hindwings as forewings but without basal line.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in December and May; four specimens received from Mr. F. P. Dodd, of which one is in the British Museum.

SYLEPTA TRACHELOTA, *n. sp.*

τραχηλοτος, with conspicuous throat.

♀ 30-38 mm. Head and palpi ferruginous-brown. Pectus with a large fan-shaped patch of white scales immediately behind palpi. Thorax ferruginous-brown; posterior edge brown-whitish. Abdomen fuscous-brown; basal segments ferruginous; underside whitish. Legs brownish; anterior pair and all tarsi fuscous with whitish annulations. Forewings triangular, costa straight for $\frac{3}{4}$, then strongly arched, apex rectangular, termen bowed, oblique; bright ferruginous mixed with ochreous-yellow; markings dark-fuscous; a sub-basal dorsal dot; a waved transverse line at $\frac{1}{5}$; a round sub-costal dot at $\frac{1}{4}$, and a transverse median sub-costal mark in disc; a line from $\frac{3}{4}$ costa, irregularly dentate, displaced outwards in middle, then bent inwards to beneath discal mark, and again bent to mid-dorsum; a broad fuscous terminal band touching posterior line on projection only; a series of dark-fuscous

terminal dots on veins; cilia fuscous. Hindwings fuscous more or less suffused with ferruginous; an oblique dark-fuscous mark at $\frac{1}{3}$ towards costa; a postmedian line at $\frac{2}{3}$, displaced outwards in middle, the projection with three rounded dentations; this line is edged posteriorly with ochreous; terminal dots and cilia as forewings.

Type in Coll., Turner.

N.Q. Evelyn Scrub, near Herberton, in October and November; four specimens received from Mr. F. P. Dodd, of which one is in the British Museum.

SYLEPTA SPILOCROSSA, *n. sp.*

σπιλοκροσσος, with spotted border.

♂ ♀ 18-20 mm. Head, palpi, and thorax fuscous mixed with whitish. Antennæ grey, annulated with dark-fuscous; ciliations in ♂ 1. Abdomen fuscous; apices of second, third, sixth, and seventh segments white; tuft ochreous-whitish. Legs whitish annulated with dark-fuscous. Forewings elongate, ovate-triangular, costa straight at base, moderately arched beyond middle, apex obtusely rounded, termen slightly bowed, oblique; whitish suffused with brownish-fuscous; markings dark-fuscous; sometimes a dark basal patch; a transverse line at $\frac{1}{4}$; a rather broad reniform discal spot beneath mid-costa, its centre brownish; two or three brownish-centred costal spots variably developed; posterior line from $\frac{5}{6}$ costa towards tornus straight and finely dentate; then obtusely curved to below discal spot, again curved to end in dorsum at $\frac{2}{3}$, a small posterior tooth above dorsum; a terminal series of dots; cilia whitish, bases brownish-tinged, with a median series of fuscous dots alternating with those on termen. Hindwings as forewings but without discal mark; first line from $\frac{1}{3}$ costa to $\frac{2}{3}$ dorsum; second line from $\frac{2}{3}$ costa, bent outwards in middle and then dentate, towards but not reaching tornus.

Not closely allied to any other species known to me, and not quite certain in its generic position.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in June and October; three specimens.

Gen. ELLOGIMA, nov.

ἐλλογιμος, noticeable.

Frons flat, oblique. Tongue well-developed. Palpi moderate, porrect; second joint thickened with appressed hairs above and beneath; terminal joint short, acute. Antennæ of ♂ thickened and bent downwards at $\frac{1}{3}$, with dense short hairs on underside of bend. Forewings with obtusely rounded apex; 8, 9, 10 stalked. Hindwings with discocellular very oblique, 3, 4, and 5 from angle, and 7 anastomosing with 8 for some distance.

Allied to *Camptomastyx*, Hmps., but with much shorter palpi.

Ellogima macroperalis.

Piletocera macroperalis, Hmps., Tr. E. S., 1897, p. 214.

♂ 18-20 mm. Head fuscous. Palpi fuscous; undersurface except apex white. Antennæ fuscous; ciliations in ♂ 1. Thorax and abdomen fuscous. Legs whitish. Forewings elongate, costa strongly concave in middle, strongly arched before apex, apex very obtusely rounded, termen slightly bowed, oblique; fuscous with darker lines; an irregularly wavy, fine, obscure, transverse line at $\frac{1}{4}$; a suffused discal spot beneath mid-costa; postmedian line more distinct, finely dentate, from $\frac{3}{4}$ costa, produced outwards in mid-disc, then bent inwards to beneath discal dot, and again bent to $\frac{3}{4}$ dorsum; apical area suffused with leaden-fuscous; cilia pale-fuscous with a darker sub-basal line. Hindwings fuscous; lines obsolete; cilia as forewings.

N.Q. Cooktown; Kuranda near Cairns, in October and December; Q. Brisbane, in November and January.

Gen. METALLARCHA.

Metallarcha, Meyr., Tr. E. S., 1884, p. 331.

This genus and the allied endemic genera require careful differentiation from each other, and from *Loxostege*, Hb. (*Phlyctænodes*, Gu.), of which the two species *affinitalis*, Led., and *massalis*, Wlk., occur in Australia.

I suggest the following scheme of differentiation :—

A. Maxillary palpi not dilated.

B. Frons with a short, stout, acute prominence, nearly forming an equilateral triangle .. Loxostege, Hb.

BB. Frons with a very long, flattened, acute prominence .. .. .. Panopsia, *n.g.*

BBB. Frons with a moderately long, cone-shaped, blunt prominence .. .. Metallarcha, Meyr.

BBBB. Frons with a moderately long, abruptly truncate prominence excavated at apex .. Criophthona, Meyr.

AA. Maxillary palpi dilated at apex. Frons with a moderately long, cone-shaped, blunt prominence .. .. .. Conoprora, *n.g.*

To the genus *Panopsia* besides the type *calliaspis*, Meyr., are to be referred *tetraplaca*, Meyr., *pseliota*, Meyr., and *goudii*, Low.

GEN. METALLARCHA.

Metallarcha, Meyr., Tr., E.S., 1884,p. 331.

Frons with a moderately long, cone-shaped, blunt prominence. Tongue well-developed. Palpi rather long, porrect, long-haired beneath; terminal joint concealed. Maxillary palpi not dilated at apex. Antennæ of ♂ simple, shortly ciliated. Tibiæ with outer spurs shorter than inner. Neuration normal.

Type M. *diplochrysa*, Meyr., To this genus I refer also *epichrysa*, Meyr., *eurychrysa*, Meyr., *crocanthes*, Low., and *leucodetis*, Low.

METALLARCHA PHÆNOLIS, *n. sp.*

φαινολις, light-bringing.

♂ ♀ 15-16 mm. Head yellow. Palpi fuscous; beneath whitish-ochreous. Antennæ pale-fuscous; ciliations in ♂ 1. Thorax yellow; shoulders narrowly leaden-fuscous. Abdomen pale-ochreous. Legs pale-ochreous; anterior pair leaden-fuscous. Forewings elongate-triangular, costa gently arched, apex round-pointed, termen strongly oblique, in ♂ nearly straight, in ♀ bowed; whitish irrorated with leaden-fuscous, more densely so on costa; markings bright orange; a broad streak along dorsum from base to ⅓, abruptly truncate; a fascia from dorsum just before middle nearly to but not reaching mid-costa; a second fascia from costa before apex almost to tornus,

slightly curved inwards; (cilia abraded). Hindwings and cilia pale-ochreous.

Type in Coll., Turner.

Q. Adavale (western interior), in April; two specimens.

CRIOPHTHONA DELOTYPA, *n. sp.*

δηλοτυπος, clearly marked.

♀ 16 mm. Head whitish-ochreous. Palpi pale-fuscous; undersurface white. Antennæ whitish-ochreous. Thorax whitish-ochreous with a few fuscous scales. Abdomen ochreous-whitish; apices of segments narrowly fuscous. Legs ochreous-whitish. Forewings elongate-triangular, costa slightly sinuate, apex rounded, termen bowed, oblique; whitish-ochreous with slight fuscous irroration; markings dark-fuscous: a dot on dorsum near base; a line from $\frac{1}{4}$ costa, bent outwards in disc, and then straight to $\frac{1}{3}$ dorsum; a longitudinally oval pale-centred sub-costal spot at $\frac{1}{3}$; a similar spot beneath mid-costa, transversely oval; a sinuate line from $\frac{3}{4}$ costa, bent outwards in mid-disc, parallel to termen for a short distance, then bent sharply inwards to beneath median spot, and bent again to end in $\frac{2}{3}$ dorsum; an interrupted terminal line; cilia whitish. Hindwings as forewings, but without discal spots; first line from $\frac{1}{3}$ costa to dorsum near tornus; second line forming three large dentations, from $\frac{2}{3}$ costa to termen beyond tornus; terminal line not interrupted.

Type in Coll., Turner.

N.Q. Stannary Hills; one specimen received from Dr. T. Bancroft.

CRIOPHTHONA CELÆNOPHAËS, *n. sp.*

κελαινοφαης, dusky.

♀ 25 mm. Head, thorax, and antennæ fuscous. Palpi fuscous; beneath white. Abdomen pale-fuscous; apices of all but basal segments whitish. Legs white; all femora and anterior aspect of anterior tibiæ and tarsi fuscous. Forewings elongate-triangular, costa nearly straight, apex rather acute, termen bowed, oblique; fuscous; first line and discal spot obsolete; a finely dentate dark-fuscous line from $\frac{4}{5}$ costa towards tornus, near this bent

inwards, and again downwards to $\frac{2}{3}$ dorsum ; an interrupted dark-fuscous terminal line ; cilia fuscous. Hindwings as forewings, but postmedian line indistinct.

Much larger than the other species but agreeing structurally.

Type in Coll., Turner.

Q. Stradbroke Island, in February ; one specimen.

Gen. CONOPRORA, nov.

κωνοπρωρος, with cone-shape prow.

Frons with a moderately long cone-shaped frontal process. Tongue well-developed. Palpi moderate, porrect ; second joint rather long with dense hairs above and beneath ; terminal joint concealed. Maxillary palpi dilated with hairs. Antennæ of ♂ simple or slightly dentate, with short or moderately long ciliations. Legs with outer spurs rather shorter than inner. Neuration normal.

Differs from *Criophthona* in the frontal process not being truncate, from *Metallarcha* in its being proportionately shorter, stouter, and more obtusely pointed, from both in the dilated maxillary palpi.

Type *C. ecista*.

Conoprora ecista, *n. sp.*

ἥκιστος, very small.

♂ ♀ 10-12 mm. Head fuscous mixed with whitish. Palpi moderately long (3) ; fuscous, beneath white. Antennæ pale-fuscous ; in ♂ thicker, annulated with whitish, and with moderately long ciliations (1). Thorax fuscous. Abdomen fuscous mixed with whitish. Legs grey-whitish. Forewings elongate-triangular, apex rounded, termen slightly bowed, oblique ; whitish irrorated with fuscous, less so towards dorsum ; markings dark-fuscous ; slightly outwardly oblique lines from $\frac{1}{4}$ and mid-dorsum, not reaching costa ; a wavy line from $\frac{4}{5}$ costa to before tornus ; cilia whitish, with a basal row of dark-fuscous dots. Hindwings fuscous ; lines indistinct or obsolete ; cilia as forewings.

Type in Coll., Turner.

N.A. Port Darwin, in October, November and December ; three specimens received from Mr. F. P. Dodd.

CONOPRORA CELIDOTA, *n. sp.*

κηλιδοτος, blotched.

♂ 9 mm. Head whitish. Palpi dark-fuscous; beneath white. Antennæ whitish; in ♂ slightly dentate with very short ciliations ($\frac{1}{4}$). Thorax fuscous. Abdomen fuscous mixed with whitish. Legs whitish; anterior pair fuscous; anterior tarsi with whitish annulations. Forewings elongate-triangular, costa nearly straight, apex rounded, termen bowed, oblique; dark-fuscous mixed with whitish; lines obsolete; a quadrangular whitish blotch on dorsum before tornus; a median white dot in disc above this, surrounded by fuscous; cilia fuscous, with an interrupted basal whitish line. Hindwings grey; an obscure whitish blotch in disc above tornus; cilia as forewings.

Type in Coll., Turner.

N.A. Port Darwin, in December; one specimen received from Mr. F. P. Dodd.

CONOPRORA ANERASMIA, *n. sp.*

ἀνερασμιος, unlovely.

♀ 11 mm. Head, antennæ, thorax, and abdomen fuscous. Palpi moderate ($2\frac{1}{2}$); fuscous, beneath whitish Legs whitish. Forewings elongate-triangular, costa nearly straight, apex rounded, termen slightly bowed, oblique; fuscous, markings obsolete; a darker dot on $\frac{4}{5}$ costa from which a faint dentate transverse line can be traced for a short distance; cilia fuscous with a darker basal line. Hindwings and cilia as forewings.

Type in Coll., Turner.

N.A. Port Darwin, in December; one specimen received rom Mr. F. P. Dodd.

CONOPRORA TRIPLEX, *n. sp.*

Triplex, threehold.

♂ ♀ 14 mm. Head whitish, posteriorly fuscous. Palpi moderately long (♂ $2\frac{1}{2}$, ♀ 3); fuscous, beneath white. Antennæ fuscous-whitish; in ♂ very shortly ciliated ($\frac{1}{4}$). Thorax and abdomen whitish. Legs whitish. Forewings elongate-triangular, costa nearly straight, apex rounded, termen bowed, strongly oblique; three oblique fuscous lines, first from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, second slightly beyond

middle, third from $\frac{4}{5}$ costa to before tornus; an indistinct interrupted terminal line; cilia whitish. Hindwings grey-whitish; cilia whitish.

Type in Coll., Turner.

Q. Adavale, in April; two specimens.

CONOPRORA BALIOCROSSA, *n. sp.*

βαλιοκροσσος, with spotted border.

♂ 17-20 mm. Head and thorax fuscous. Palpi $2\frac{1}{2}$; fuscous; beneath with basal half white. Antennæ fuscous; ciliations in ♂ $\frac{1}{4}$. Abdomen fuscous; apices of segments whitish. Legs fuscous; posterior pair whitish; tarsi annulated with whitish. Forewings elongate-triangular, costa nearly straight, apex rounded, termen bowed, oblique; fuscous mixed with whitish, appearing rather dark-grey; darker along costa; markings dark-fuscous; a line from $\frac{1}{5}$ costa to $\frac{1}{3}$, dorsum outwardly curved; a median line from mid-costa to $\frac{2}{3}$ dorsum, interrupted beneath costa by a slender reniform whitish annulus with dark-fuscous centre; an irregularly dentate line from $\frac{3}{4}$ costa to tornus; a fine terminal line; cilia pale-fuscous with a basal series of whitish dots. Hindwings fuscous; cilia as forewings.

Larger than the other species and with the maxillary palpi less dilated, but agreeing in the shape of the frontal process.

Type in Coll., Turner.

Q. Stradbroke Island, in November; three specimens.

GEN. METASIA.

Metasia, Gn., Delt. and Pyr., p. 251., Hmps., P.Z.S., 1899, p. 236.

Frons with a rounded or very shortly conical projection.

To this genus I refer *achœalis*, Wlk., in spite of its somewhat larger size and brighter colouring as compared with the other species.

METASIA THELCTERIA, *n. sp.*

θελκτηριος, charming.

♂ 13 mm. Head and thorax yellow. Palpi 2; yellow, base beneath white. Antennæ whitish; ciliations in ♂

minute. Abdomen whitish-ochreous. Legs white. Forewings triangular, costa nearly straight, apex rounded, termen bowed, oblique; yellow; markings blackish, very distinct; a dot on dorsum at $\frac{1}{5}$, a second beneath costa at $\frac{1}{3}$, and a third in disc between but rather internal to these; a dot beneath mid-costa; a slender line from $\frac{3}{4}$ costa, bent slight outwards in disc, then parallel to termen, until bent inwards beneath discal dot, then abruptly bent and dentate to $\frac{2}{3}$ dorsum; a series of terminal dots; cilia fuscous-whitish. Hindwings fuscous-whitish; a few pale-fuscous terminal dots; cilia fuscous-whitish, becoming ochreous-whitish towards termen.

Type in Coll., Turner.

N.A. Port Darwin, in February; one specimen received from Mr. F. P. Dodd.

METASIA GALBINA, *n. sp.*

Galbinus, yellowish.

♀ 16 mm. Head, antennæ, thorax, and abdomen pale-ochreous. Palpi $2\frac{1}{2}$; brownish-ochreous, beneath white nearly to apex. Legs whitish-ochreous. Forewings elongate-triangular, apex round-pointed, termen bowed, oblique; ochreous-yellow marking fuscous, indistinct; a dot on fold with some fuscous scales between it and dorsum representing first line; a very faint annular discal spot beneath mid-costa; a finely dentate line from $\frac{3}{4}$ costa, bent slightly outwards in disc, parallel to termen for a short distance, then bent inwards to beneath discal spot, again bent, and ending on $\frac{2}{3}$ dorsum; an interrupted terminal line; cilia fuscous-whitish. Hindwings as forewings, but without first line and discal spot.

Type in Coll., Turner.

N.A. Port Darwin, in November; one specimen received from Mr. F. P. Dodd.

NOORDA HEDYPHAËS, *n. sp.*

ὑδυφαης, sweetly shining.

♀ 16-17 mm. Head and thorax whitish-yellow; base of patagia ferruginous. Palpi ferruginous irrorated with fuscous, internal surface white. Antennæ whitish-yellow. Abdomen whitish-yellow, sides and under-surface white.

Legs white ; anterior femora and tibiæ ferruginous-fuscous. Forewings triangular, costa staight to near apex, apex round-pointed, termen bowed, oblique ; 10 separate but very closely approximated to 8, 9 ; whitish-yellow with an oily gloss ; a ferruginous costal streak from base to $\frac{3}{5}$, extreme costal edge dark-fuscous to same extent ; three dark-fuscous dots, first sub-costal at $\frac{1}{4}$ touching costal streak, second on dorsum at $\frac{1}{3}$, third in middle of disc at lower angle of cell ; a crimson terminal band edged by a dark-fuscous line acutely indented on vein 4 ; within band is a suffused subterminal fuscous line, beyond which termen is pale-crimson with darker interneural dots ; cilia yellow, apices paler. Hindwings with termen well rounded ; white, semitranslucent ; a median crimson spot on termen bounded by a dark-fuscous line except costally, where it is continued by a pale-fuscous band nearly to apex ; cilia white, bases on apical half of wing yellowish.

Allied to *N. fessalis*, Swin.

Type in Coll., Turner.

N.A. Port Darwin, in September and November ; three specimens received from Mr. F. P. Dodd.

MYRIOSTEPHES XUTHOSPILA, *n. sp.*

ξουθοσπιλος, tawny-spotted.

♂. ♀ 12-13 mm. Head orange-ochreous ; face dark-fuscous. Palpi 2, dark-fuscous ; beneath whitish-ochreous from base to middle of second joint. Antennæ dark-fuscous ; ciliations in ♂ minute. Thorax dark-fuscous. Abdomen yellow-ochreous ; bases of segments dark-fuscous on dorsum. Legs dark-fuscous annulated with whitish-ochreous ; posterior pair whitish-ochreous. Forewings triangular, costa straight, slightly arched towards apex, apex round-pointed, termen nearly straight, moderately oblique ; blackish-fuscous with orange-ochreous spots ; a sub-basal spot on dorsum extending $\frac{2}{3}$ across disc ; a rather large roundish spot on mid-dorsum ; a triangular spot on costa at $\frac{2}{3}$; a smaller spot on tornus, more or less confluent with a spot just above it ; cilia blackish-fuscous. Hindwings and cilia dark-fuscous.

Type in Coll., Turner.

N.A. Port Darwin, in December and March ; two specimens received from Mr. F. P. Dodd.

MYRIOSTEPHES ARGYPHEA, *n. sp.*

ἀργυφεος, silver-white.

♂ ♀ 12 mm. Head dark-fuscous. Palpi 2; dark-fuscous. Antennæ pale-fuscous; in ♂ serrate and minutely ciliated. Thorax dark-fuscous; patagia snow-white. Abdomen pale-ochreous. Legs dark-fuscous; middle tarsi with slender whitish annulations; posterior pair whitish; posterior tarsi beneath fuscous barred with whitish. Forewings triangular, costa gently arched, more strongly in ♀, apex round-pointed, termen bowed, oblique; snow-white; a dark-fuscous streak on costa to middle; a broad median fascia, its costal half dark-fuscous, dorsal half orange-ochreous; a broad sub-terminal orange-ochreous fascia, suffused with dark-fuscous towards apex, bounded by a finely waved dark-fuscous line; a white dot on costa before apex; a white streak on termen, but terminal edge fuscous; cilia ochreous. Hindwings grey; cilia ochreous-whitish, tipped with grey at apex.

This and the two following species are closely allied, but distinct.

Type in Coll., Turner.

N.A. Port Darwin, in February and March; two specimens received from Mr. F. P. Dodd.

MYRIOSTEPHES CATAXIA, *n. sp.*

καταξιος, of good worth.

♂ 9-10 mm. Head white. Palpi $2\frac{1}{2}$; dark-fuscous; inner aspect of maxillary palpi white. Antennæ fuscous-whitish; in ♂ slightly serrate and minutely ciliated. Thorax white; patagia crossed by a pale fuscous bar. Abdomen whitish. Legs dark-fuscous with white annulations; posterior pair except tarsi whitish. Forewings triangular, costa nearly straight, apex rounded, termen slightly bowed, slightly oblique; snow-white with pale ochreous-fuscous fasciæ; first fascia sub-basal, slender, expanded at extremities, with a blackish dot on middle of posterior margin; second fascia at $\frac{1}{3}$, broad, its anterior edge partly outlined with blackish; third fascia at $\frac{4}{5}$, broad with very irregular margins, enclosing a white dot on costa, its anterior edge partly outlined with blackish, its posterior edge giving off a process to mid-termen; a sub-terminal

and terminal series of fuscous dots; cilia whitish, bases dark-fuscous. Hindwings pale-grey; cilia whitish, bases pale-grey.

Type in Coll., Turner.

N.A. Port Darwin, in February; four specimens received from Mr. F. P. Dodd.

MYRIOSTEPHES POLYZELOTA, *n. sp.*

πολυζήλωτος, much desired.

♂ 10 mm. Head white. Palpi $2\frac{1}{2}$; dark-fuscous. Antennæ fuscous; in ♂ slightly serrate and minutely ciliated. Thorax fuscous; patagia pale-fuscous. Abdomen pale-fuscous; dorsum of first segment whitish. Legs dark-fuscous with whitish annulations; posterior pair except tarsi whitish. Forewings triangular, costa slightly arched, apex round-pointed, termen slightly bowed, moderately oblique; white with dark-fuscous fasciæ partly edged with blackish; a small basal fascia connected with second fascia by a costal streak; second fascia at $\frac{1}{3}$, rather broad, its edges irregularly dentate; third fascia at $\frac{4}{5}$, irregularly margined, enclosing a white dot on costa, connected by a bar with mid-termen; a dark-fuscous subterminal line; cilia fuscous. Hindwings grey; cilia whitish, bases grey.

Type in Coll., Turner.

N.A. Port Darwin, in January and February; two specimens received from Mr. F. P. Dodd.

MYRIOSTEPHES EPARGYRA, *n. sp.*

ἐπάργυρος, overlaid with silver.

♂ 10 mm. Head, thorax, and abdomen reddish-brown. Palpi $2\frac{1}{2}$; reddish-brown. Antennæ reddish-brown; in ♂ slightly dentate and minutely ciliated. Legs reddish-brown. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, oblique; reddish-brown with silvery white fasciæ; first fascia sub-basal, rather obscure, not quite reaching costa; second fascia from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum, its posterior edge wavy; third fascia narrow, sub-terminal, interrupted in middle; cilia whitish, bases fuscous. Hindwings brown-whitish; a fine fuscous line at $\frac{2}{3}$ and another on termen, neither reaching dorsum; cilia as forewings.

Type in Coll., Turner.

N.A. Port Darwin, in February; two specimens received from Mr. F. P. Dodd.

Gen. EMPHYLICA, nov.

ἐμφυλικος, of the same race.

Frons with a rounded short conical projection. Tongue well-developed. Palpi rather long, porrect, densely clothed with appressed hairs, terminal joint concealed, slightly turned downwards. Maxillary palpi large, triangularly dilated. Neuration normal. Tibiæ with outer spurs about half-inner.

Allied to *Myriostephes* which it resembles in the triangular maxillary palpi, but with a conical frons like that of *Loxostege*.

Emphylica xanthocrossa, *n. sp.*

ξανθοκροσσος, yellow-edged.

♀ 14 mm. Head pale-ochreous. Palpi orange-ochreous at base white. Antennæ fuscous, towards base ochreous. Thorax ochreous; patagia fuscous; pectus white. Abdomen fuscous; base, sides, and tuft ochreous; beneath whitish-ochreous. Legs whitish-ochreous; middle pair white; anterior tarsi with white annulations. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen slightly bowed, rather strongly oblique; purple-reddish; a large triangular orange spot on costa beyond middle; cilia orange. Hindwings whitish-ochreous; a broad pale-fuscous terminal band; terminal edge orange except towards tornus; cilia orange, on fornus pale-fuscous.

Type in Coll., Turner.

N. A. Port Darwin, in November and January; two specimens received from Mr. F. P. Dodd.

Heliothela floricola, *n. sp.*

Floricolus, flower-haunting.

♂ 10-12 mm. Head blackish. Palpi blackish; lower surface of second joint except at apex and base of third joint white. Antennæ blackish; ciliations minute. Thorax and abdomen blackish. Legs blackish; tarsi with obscure whitish annulations. Forewings oblong, posteriorly

dilated, costa straight, apex rounded, termen bowed, scarcely oblique; blackish with a few white scales; a white spot variably developed on $\frac{3}{4}$ costa reaching half across disc; lines black; first from $\frac{1}{4}$ costa to $\frac{1}{3}$ termen, outwardly curved; second from $\frac{3}{4}$ costa towards tornus, bent inwards around white spot, and then downwards to $\frac{2}{3}$ termen; cilia blackish, apices whitish. Hindwings blackish; a pure white spot from mid-costa reaching middle of disc; sometimes also a smaller spot above and external to tornus; cilia as forewings.

♀ differs as follows:—14-16 mm. Hindwings without white spot, but with a few scattered whitish or ochreous scales in disc.

Types in Coll., Turner.

N.S.W. Mt. Kosciusko (5000 to 6000 ft.), in March; a series taken flying in the sunshine and resting on the flower heads of *Compositæ*.

FAM. PTEROPHORIDÆ.

PLATYPTILIA EUCTIMENA, *n. sp.*

εὐκτιμενος, well-built.

♂ ♀ 24-26 mm. Head brownish. Palpi short ($1\frac{1}{2}$), slender; brownish, internal surface whitish. Antennæ brownish; ciliations in ♂ $\frac{1}{2}$. Thorax brownish. Abdomen brownish; base and under-surface brown-whitish. Legs fuscous-brown; tarsi whitish. Forewings pale-brownish with some whitish irroration; a median fuscous dot at $\frac{1}{3}$ and two fuscous dots just before cleft; a short whitish streak on sub-apical part of costa; a fine whitish line across costal segment shortly before apex; cilia brown-whitish, a series of basal fuscous dots, one on mid-dorsum, one on dorsum at $\frac{3}{4}$, one on tornus, one on apex of dorsal segment, and one on lower angle of costal segment, two fuscous streaks one before last-mentioned dot and one at apex. Hindwings brown; cilia pale-grey.

Type in Coll., Turner.

N.Q. Kuranda, near Cairns, in June. Q. Brisbane, in May; Toowoomba, in November. Four specimens of which one is in Coll., Meyrick.

Fam. ORNEODIDÆ.

Three Australian species of this very curious family have been described, and I am now able to add a fourth and fifth.

ORNEODES PYGMÆA.

N.A. Port Darwin.; N.Q. Cairns, Townsville; Q. Brisbane, Toowoomba.

ORNEODES PHRICODES.

I have bred this species from larvæ feeding in the flowerbuds of *Tecoma jasminoides* growing in the wild.

N.Q. Cairns, Herberton, Townsville. Q. Nambour, Brisbane, Mt. Tambourine, Southport.

ORNEODES XANTHODES.

N.Q. Townsville.

ORNEODES ACASCÆA, *n. sp.*

ἀκασκαιος, delicate.

♀ 9 mm. Head, thorax, palpi, and antennæ white. Palpi moderate, ascending; terminal joint about ½ second. Abdomen whitish with several median reddish-fuscous dots. Legs white. Forewings white; markings very pale reddish-fuscous; first segment with a broad fascia beyond middle and a second before apex; other segments with similar markings but much less pronounced; cilia white. Hindwings white; segments barred at intervals by fuscous irroration; cilia white.

In size and fragility this agrees with *O. pygmæa*.

Type in Coll., Turner.

N.Q. Cardwell, in August; one specimen.

ORNEODES AGAPETA, *n. sp.*

ἀγαπητος, lovely.

♂ 17 mm. Head white; face grey with some white scales. Palpi short, ascending; terminal joint ¼; whitish. Antennæ grey-whitish; in ♂ finely serrate and minutely ciliated. Thorax and abdomen white. Legs white; anterior pair suffused with fuscous anteriorly. Forewings white; costa interruptedly fuscous; first segment with four or five pale-fuscous bars in posterior half; bars formed by dark-fuscous irroration on second, third, fourth, and fifth

segments before middle; broad pale-fuscous fasciæ edged by dark-fuscous scales on second and third segments at $\frac{5}{6}$, on fourth and fifth segments at $\frac{3}{4}$, and on sixth segment at $\frac{2}{3}$; pale-fuscous sub-terminal bars and dark-fuscous terminal dots on all segments; cilia white, on apices of segments pale-fuscous. Hindwings as forewings but ante-median bars nearer to base, and with a faintly-marked series of median bars.

Near *O. xanthodes* though very different in coloration.

Type in Coll., Turner.

N.A. Port Darwin, in April; one specimen received from Mr. F. P. Dodd.

ADDENDUM.

Sub. Fam. CRAMBINÆ.

Gen. ORESSAULA nov.

ὀρεσσαυλος, dwelling in the mountains.

Frons flat, hairy. Tongue well-developed. Palpi moderately long, porrect, densely clothed with very long hairs beneath, terminal joint concealed in hairs. Maxillary palpi well-developed, ending in a dense tuft of very long hairs. Antennæ, in ♂ with paired tufts of long cilia. Thorax hairy, especially on under-surface. Legs with outer spurs $\frac{2}{3}$ of inner. Forewings with 2 from $\frac{4}{5}$, 3 from shortly before angle, 4 from angle, 5 from shortly above angle, 7 and 8 stalked. Hindwings with median vein densely pectinated; discocellulars very strongly oblique, dorsal edge of cell more than twice costal; 4 and 5 connate or short-stalked, 6 from junction of upper and middle third of discocellulars well-separated from 7; 7 anastomosing at a point or very shortly with 8.

A primitive type with the neuration and pectination of hindwing of *Talis*, but in wing-shape and general appearance more suggestive of one of the lower *Pyraustinæ*. The general hairiness is rather characteristic of mountain forms.

ORESSAULA LACHNÆA. *n. sp.*

λαχναιος, hairy.

♂ ♀ 24-28 mm. Head dark-fuscous with a few whitish hairs. Palpi dark-fuscous; internal surface whitish. Antennæ dark-fuscous, ciliations in ♂ 2. Thorax dark-fuscous. Abdomen dark-fuscous; beneath mixed with whitish. Legs dark-fuscous mixed with whitish; undersurface and spurs whitish. Forewings broadly triangular, costa somewhat arched at base, then straigh , apex rounded, termen bowed, oblique; dark-fuscous irrorated with pale-ochreous and more sparsely with milk-white scales; cilia fuscous, apices whitish. Hindwings with termen rounded; ochreous-fuscous, towards base dark-fuscous; cilia as forewings.

Type in Coll., Lyell.

V. Mount Hotham, in February; six specimens. Mr. Geo. Lyell writes: "I took this species flying close to the ground on the extreme summit of Mount Hotham (just over 6,200 feet). It was a fast bustling flyer, and on account of its sombre colour, somewhat difficult to follow with the eye. A fortnight's stay at Mount St. Bernard, at a couple of hundred feet lower elevation, failed to find it."

THE FREEZING POINT OF MILK.

By J. BROWNLIE HENDERSON, F.I.C. and L. A. MESTON.

PLATE X.

(*Read before the Royal Society of Queensland, July 31st,* 1912.)

At the Australasian Association for the Advancement of Science Meeting in Brisbane in 1909, a paper was read by Mr. Henderson on " The Freezing Point of Milk ; Its Use in the Detection of Added Water " and the paper was published in the printed Proceedings of that meeting.

So many inquiries were subsequently made for copies of the paper that the Authors' Copies have long since been exhausted, and it was thought advisable to put on record a more complete description of the work done on the subject at the Government Chemical Laboratory, Brisbane, and to record the results of the practical working of this process in a Foods Laboratory for over five years.

A short paper on the same subject by the same author was published in Vol. XIII. of the Australasian Association for the Advancement of Science.

No article of food has caused more trouble to food analysts than milk, firstly owing to the extremely important place it holds as an article of diet,, and then owing to the great variations in its composition. Attempts to regulate the quality by fixing a minimum standard at once led to the watering down of rich milk to that low standard.

The legal standard for milk in Queensland is :—" Milk shall be the normal, clean, and fresh secretion obtained by completely emptying the udder of the healthy cow, properly fed and kept, excluding that got during fifteen days immediately before, and ten days immediately following on, parturition. It shall contain not less than eight and five-tenths per centum of milk solids not fat, three and three-tenths per centum of milk fat, and not less than twelve parts per centum of total solids; its freezing point shall not be higher than 0·55°C below zero."

This is a distinct advance on the old 8.5 Solids not Fat and 3·0 per cent. Fat standard which almost invariably permitted the addition of at least 4·0 per cent. of water without the mixture falling below the standard. The average of the milk supply of Brisbane is 8·9 per cent. Solids not Fat, and 4·1 per cent. of Fat.

So far as we know this is the first occasion in the history of milk control that the freezing point has actually been included in the legal minimum standard, though on the continent of Europe its use by food analysts in judging the quality of milk is by no means new. It is worthy of note that in Queensland there is no "appeal to the cow." The law provides not only that the milk shall be pure and clean and from healthy cows, but that it shall reach the above noted composition. Pure milk, which owing to its being derived from herds of unsuitable breed or from herds badly fed, falls below the prescribed standard may not be sold in Queensland.

In the paper above referred to it was pointed out that the attempts to solve the problem of added water in milk by treatment of the milk serum had all proved of little practical value. The refractive index method of which most was expected has been shown to be of little use. The index reading varies between thirty-nine and forty-six, which means that a rich 46 milk might have nearly 20 per cent. of water added to it ere falling below the 39 minimum. Apart from the manipulation difficulties which are not small, the range of readings on genuine milk makes the process of little value.

Since E. Beckmann (Milch Zeitung, 1894) drew attention to the constancy of the freezing point of milk, and Winter in 1895 reported his work confirming it, the results

of hundreds of thousands of analyses have added to the certainty of the position. The freezing point of fresh milk from a herd of cows seems never to vary further than from $-0{\cdot}55^\circ$ C. to $-0{\cdot}56^\circ$ C. with a mean of $-0{\cdot}555^\circ$ C. The maximum variation represents about 2 per cent. of added water, while the working error of the process is less than 0·5 per cent. of added water.

Before dealing with the details of the method, it might be well to note the reasons for the constancy of the freezing point of a substance of such variable composition as milk.

The freezing point of a solution of a substance in water depends mainly on the number of crystalloid ions dissolved in the solution.

Substances which are not in solution, like fat, do not affect the freezing point. As fat is the most variable component of milk, the most varying factor is removed from affecting the result. Substances also which are in "colloid" solution such as the albumenoids affect the freezing point either not at all or only to a very slight extent, and in any case as the molecular weight of the albumenoids is very high, their relative effect on the freezing point is very small.

Thus the second most variable constituent of milk does not appreciably affect the result. The milk sugar content of milk is fairly regular, but again we are dealing with a substance of high molecular weight and with a correspondingly small effect on the freezing point.

It will thus be evident that we get down to the small proportion of other constituents ere we get the substances which control the freezing point, and it seems that these, as in the blood of nearly all animals, are almost perfectly constant in proportion.

The freezing point of milk is, therefore, not in any degree whatever a measure of the proportion of Total Solids or Solids not Fat present.

We have found milks of known genuine origin from small herds, with Solids not Fat 9·7 per cent. and 7·6 per cent. as well as those of normal composition give exactly $-0{\cdot}555^\circ$ C. freezing point.

The following references to work done on the freezing point of milk are worth noting :—

Dr. Barthel ("Methods used in the Examination of Milk and Dairy Products, 1910") refers to the freezing point of milk as follows :—

"This method of determining the amount of added water is very simple and perfectly reliable if carried out carefully. It is remarkable that it has not found more general application, for it not only shows that water has been added, but gives also the amount with accuracy. The author has experimented with this method and is quite satisfied that the results are reliable, and that in agreement with Winter and Parmentier, Schnorf, and others, pure unadulterated milk never has a higher freezing point than —0·54° C. This is independent of breed, individuality, sexual excitement, the amount of fat, etc., but a very small addition of water at once raises the freezing point."

J. Cornalba ("On the Milks of Lombardy, Chemiker Zeitung, 1907-1909") shows the constancy of the freezing point to fall between —0·55° C. and —0·56° C. He also points out that colostrum with salts ranging between 0·9 per cent. and 1·12 per cent. gave normal freezing points.

J. Winter and E. Parmentier obtained from single cows freezing points varying from —0·54° C. to —0·57° C. The mixed milk from a herd never rose above —0·55° C. or fell below —0·56° C.

P. Ducross and H. Imbert (Bull. Sciences Pharmacal, 1905) obtained a value of —0·533° C. from a sick cow and a sample of milk from a cow in calf gave a freezing point of —0·535° C.

Beckmann & Jordis (Forschungs berichte uber Lebensmittel, 1895, Vol. II.) found the average freezing point to be —0·554° C.

It seems that for the mixed milk of a herd there is variation between only —0·55° C. and —0·56° C., but for milk from single cows in a diseased or abnormal state wider variations may occur.

The freezing point method places us in a sound position as regards the milk control. In the past, on the old standard an honest milk vendor was liable to be prosecuted for

selling as watered milk, genuine milk which simply failed to reach the legal standard. On the freezing point test, we have been able to warn three vendors in the last three years that the milk they were vending was genuine but below the legal standard, and that they had better take steps to improve their herds by feeding or "culling" in order to meet the standard.

It has been pointed out by one or two critics of the freezing point method that the results can easily be masked by the addition of substances which depress the freezing point.

Any of the substances likely to be used in this direction can be readily detected by an analyst. Many tests at the disposal of the analyst are liable to be masked, and it is part of his duty to look out for this masking, as for example the masking of the heat test of explosives by the addition of mercuric chloride, the masking of Becchi & Halphen reactions for cotton seed oil by boiling the oil and other treatment, and the masking of Hehner's reaction for formaldehyde by adding sodium nitrite.

The freezing point is such a sensitive test however that if the ordinary dairyman did start tampering with the milk he would either add too little to cover the addition of water or add too much and make the freezing point abnormal.

For the last four years in the Government Chemical Laboratory, Brisbane, every legal sample of milk for prosecution purposes has been checked by this method, and most of the results are shown in Tables A. B., and C.

Table A. shows results obtained on legal samples of milk taken during the last three years, wherein an increased acidity had developed. When the milk becomes acid the larger molecules are decomposed into a number of smaller ones. The osmotic pressure increases and the freezing point is further depressed. Without this knowledge the results in Table A. would make it appear that some of the samples were abnormal before watering, while others were only slightly above the legal standard of 8·5 S.N.F. The added water, however (calculated on the minimum

proportion of 0·5 per cent. nitrogen and 0·7 per cent. ash, found in normal milk), is higher than that estimated from the freezing point of the sample.

We have not done sufficient work to enable us to say whether any definite relationship exists between the depression of the freezing point and the increase of acidity. It is very doubtful if any constant factor could be obtained to correct for the acidity as the fermentation products would vary with the nature of the ferment and the time and temperature of the reaction. Barthel states that the percentage of water can be determined fairly accurately if the acidity is 20° (Thorner) by adding 5 per cent. to the result of Winter's formula. Figures obtained by us, on a small number of samples only, indicate that 1 per cent. increase of acidity covers the addition of 0·5 per cent. of water. It is to be noted that any error introduced by the increased acidity is entirely in favour of the milk vendor.

TABLE A.

Total Solids per cent.	Fat. per cent.	Solids not Fat per cent.	Nitrogen per cent.	Ash per cent.	Acid ccs. $\frac{n}{10}$ NaOH per 100 c.cs. milk	Freezing Point. °C	Added H_2O on 8·5S.N.F	Added H_2O on F.P.
11·6	3·3	8·3	0·47	0·68	20·0	—0·540	2·3	1·8
12·4	4·2	8·2	0·47	0·66	18·4	—0·517	4·1	6·0
11·7	3·6	8·1	0·45	0·66	17·0	—0·537	4·7	2·3
12·2	4·1	8·1	0·46	0·68	15·6	—0·515	4·8	6·4
10·8	3·0	7·8	0·44	0·62	20·0	—0·500	8·3	9·1
10·6	3·0	7·6	0·42	0·63	24·0	—0·527	12·9	4·1
9·5	2·0	7·5	0·41	0·64	17·6	—0·520	11·8	5·4
8·8	2·5	6·3	0·36	0·50	17·6	—0·435	25·5	20·9

The acidity of milk is determined by Dr. Chapman's method, using 25 c.cs. of milk, 100 c.cs. of water, and 1.c.c. of 0·1 per cent. of phenol phthalein solution and titrating with $\frac{n}{10}$ NaOH. The normal acidity of milk by this method is about 13·5 c.cs. $\frac{n}{10}$ NaOH per 100 c.cs. of milk.

TABLE B.

Showing results from legal samples of milk obtained during the last three years, containing 8·5 per cent. and over of Solids not Fat.

Total Solids per cent	Fat per cent.	Solids not Fat per cent.	Nitrogen per cent.	Ash per cent	Freezing Point.	Added H_2O calculated on F.P —0·55°C per cent.
14·8	5·1	9·7		0·8	—0·555	
11·9	2·3	9·6		0·75	—0·550	
13·9	4·4	9·5		0·78	—0·555	
13·4	4·1	9·3		0·8	—0·555	
13·3	4·1	9·2			—0·561	
14·2	5·0	9·2			—0·550	
11·5	2·4	9·1	0·57	0·77	—0·550	
13·3	4·2	9·1			—0·555	
12·8	3·7	9·1			—0·543	1·2
14·2	5·2	9·0		0·71	—0·555	
14·1	5·1	9·0			—0·550	
14·4	5·4	9·0			—0·550	
13·1	4·1	9·0			—0·550	
12·4	3·4	9·0			—0·550	
13·5	4·5	9·0			—0·545	0·9
12·9	3·9	9·0			—0·545	0·9
12·8	3·8	9·0			—0·545	0·9
13·0	4·1	8·9			—0·557	
13·1	4·2	8·9			—0·557	
13·2	4·3	8·9			—0·543	1·2
12·9	4·0	8·9			—0·542	1·4
13·3	4·5	8·8			—0·560	
11·3	2·5	8·8	0·50	0·75	—0·550	
12·8	4·0	8·8			—0·550	
12·5	3·7	8·8			—0·550	
12·8	4·0	8·8			—0·544	1·0
13·3	4·5	8·8			—0·535	2·7
14·6	5·8	8·8			—0·523	4·8
13·6	4·8	8·8			—0·531	3·4
12·9	4·1	8·8			—0·520	5·4
12·6	3·9	8·7			—0·555	
13·3	4·6	8·7			—0·550	
12·4	3·7	8·7			—0·545	0·9
12·9	4·2	8·7			—0·540	1·8
13·3	4·6	8·7			—0·540	1·8
12·2	3·5	8·7			—0·510	7·2
12·6	4·0	8·6			—0·570	
12·4	3·8	8·6			—0·550	
13·2	4·6	8·6			—0·550	
12·2	3·6	8·6			—0·547	0·5
12·2	3·6	8·6			—0·547	0·5
11·7	3·1	8·6			—0·545	0·9
12·2	3·6	8·6			—0·532	3·2
12·3	3·7	8·6			—0·532	3·2
12·6	4·0	8·6			—0·530	3·6
11·3	2·8	8·5		0·72	—0·560	
11·5	3·0	8·5		0·71	—0·550	
12·2	3·7	8·5			—0·547	0·5

TABLE B—Continued.

Total Solids per cent.	Fat per cent.	Solids not Fat per cent.	Nitrogen per cent.	Ash per cent.	Freezing Point.	Added H_2O calculated on F.P. —0·55°C. per cent.
12·1	3·6	8·5			—0.544	1·0
11·7	3·2	8·5		0·69	—0.544	1·0
12·0	3·5	8·5			—0·542	1·4
12·4	3·9	8·5			—0·540	1·8
12·0	3·5	8·5		0·7	—0·540	1·8
12·6	4·1	8·5			—0·540	1·8
12·2	3·7	8·5			—0·535	2·7
12·1	3·6	8·5			—0·532	3·2
12·9	4·4	8·5			—0·530	3·6
12·5	4·0	8·5			—0·530	3·6
12·1	3·6	8·5			—0·530	3·6
12·4	3·9	8·5	0·47	0·7	—0·528	4·0
12·3	3·8	8·5		0·7	—0·527	4·1
12·3	3·8	8·5			—0·523	4·8
12·5	4·0	8·5		0·71	—0·520	5·4
12·6	4·1	8·5		0·74	—0·520	5·4

SUMMARY OF TABLE B.

Results from 64 legal samples of milk obtained during the last three years, containing from 8·5 to 9·7 per cent. of Solids not Fat.

6 Samples 9·2 to 9·7	per cent. Solids not Fat.	All normal Freezing Point.
3 Samples 9·1	per cent. Solids not Fat	2 normal Freezing Point. 1 1·2 % Water.
8 Samples 9·0	per cent. Solids not Fat	5 normal Freezing Point. 3 less than 1 % Water.
4 Samples 8·9	per cent. Solids not Fat	2 normal Freezing Point. 2 less than 1·5 % Water.
9 Samples 8·8	per cent. Solids not Fat	4 normal Freezing Point. 5 from 1 to 5·4 % Water.
6 Samples 8·7	per cent. Solids not Fat	3 normal Freezing Point. 3 from 2 to 7 % Water.
9 Samples 8·6	per cent. Solids not Fat	5 normal Freezing Point. 4 from 1 to 3·6 % Water.
19 Samples 8·5	per cent. Solids not Fat	3 normal Freezing Point. 16 from 1 to 5·4 % Water.

The amount of watering is not appreciable until the Solids not Fat figure falls below 8·9 per cent., although there are genuine milks on every figure from 8·5 to 8·9 per cent. Solids not Fat. The greatest proportion of adulteration falls on the 8·5 figure, only 3 samples being genuine out of 19 received. The actual proportion of added water read off from Winter's table is given, as obviously for this comparison any working error of the process should not be taken into account.

TABLE C.

Showing results from legal samples of milk obtained during the last three years, containing under 8·5 per cent. of Solids not Fat.

Total Solids per cent.	Fat per cent.	Solids Not Fat per cent	Nitrogen per cent.	Ash per cent.	Freezing Point. °C	Acidity	Added H_2O calculated on 8.5 S.N.F. per cent.	Added H_2O Calculated on F.P. per cent.
11·8	3·5	8·3	0·40	0·70	—0·520		2·6	5·4
11·5	3·2	8·3	0·50	0·68	—0·485	14·4	3·0	11·8
11·1	2·8	8·3	0·45	0·66	—0·480		3·0	12·7
11·6	3·3	8·3	0·49	0·69	—0·490		3·1	10·9
12·5	4·3	8·2	0·43	0·68	—0·495	13·6	3·4	10·0
11·6	3·4	8·2	0·48	0·70	—0·530		3·5	3·6
10·7	2·5	8·2	0·41	0·68	—0·528		3·8	3·9
11·5	3·3	8·2	0·49	0·66	—0·530	14·0	4·0	3·6
11·3	3·2	8·1	0·47	0·70	—0·524		4·5	4·7
11·5	3·4	8·1	0·47	0·66	—0·480		4·6	12·7
11·2	3·1	8·1	0·48	0·68	—0·510		4·7	7·2
11·9	3·8	8·1	0·44	0·68	—0·520	14·0	4·7	5·4
12·0	3·9	8·1	0·47	0·70	—0·505	12·0	4·7	8·1
11·4	3·3	8·1	0·48	0·68	—0·517		4·7	5·9
11·1	3·0	8·1	0·46	0·71	—0·510		5·0	7·2
11·6	3·5	8·1	0·47	0·72	—0·520		5·0	5·4
11·1	3·0	8·1	0·46	0·71	—0·510		5·0	7·2
11·4	3·4	8·0	0·47	0·69	—0·497	13·2	5·9	9·6
11·8	3·8	8·0	0·44	0·67	—0·505	12·0	5·9	8·1
11·0	3·0	8·0	0·49	0·72	—0·525	12·0	5·9	4·5
11·1	3·1	8·0	0·44	0·69	—0·515	12·0	5·9	6·3
10·9	2·9	8·0	0·48	0·63	—0·475		5·9	13·6
10·5	2·6	7·9	0·41	0·70	—0·460		6·6	16·5
11·0	3·1	7·9	0·45	0·64	—0·490		7·1	10·9
11·2	3·3	7·9	0·45	0·65	—0·470		7·1	14·5
11·0	3·2	7·9	0·46	0·62	—0·475		7·9	13·6
11·5	3·7	7·9	0·44	0·67	—0·500	12·8	7·6	9·1
11·8	3·9	7·9	0·44	0·67	—0·495		7·3	10·0
11·0	3·2	7·8	0·45	0·68	—0·472		8·2	14·1
11·3	3·5	7·8	0·47	0·63	—0·458	12·4	8·2	16·8
11·6	3·8	7·8	0·46	0·64	—0·507		8·2	7·7
10·9	3·1	7·8	0·48	0·64	—0·496	12·0	8·2	9·8
11·3	3·6	7·7	0·44	0·62	—0·505	12·8	8·8	8·1
11·5	3·8	7·7	0·44	0·61	—0·452	12·4	10·1	17·7
11·2	3·5	7·7	0·46	0·63	—0·470		9·4	14·5
11·3	3·6	7·7	0·46	0·65	—0·477	14·0	9·4	13·2
10·6	2·9	7·7	0·45	0·67	—0·494		9·4	10·1
11·2	3·5	7·7	0·46	0·66	—0·484		9·4	11·9
10·8	3·1	7·7	0·45	0·63	—0·492		9·4	10·5
11·8	4·1	7·7	0·47	0·65	—0·470		9·4	14·5
11·2	3·6	7·6	0·44	0·60	—0·475	13·2	10·1	13·6
10·2	2·6	7·6	0·41	0·65	—0·465	13·0	10·1	15·5
11·6	4·0	7·6	0·49	0·64	—0·502	12·0	10·4	8·7

TABLE C.—CONTINUED.

Total Solids per cent.	Fat per cent.	Solids not Fat per cent.	Nitrogen per cent.	Ash per cent.	Freezing Point. °C.	Acidity	Added H_2O calculated on 8·5 S.N.F. per cent.	Added H_2O calculated on F.P. per cent.
10·6	3·0	7·6	0·43	0·64	—0·502		10·6	8·7
10·8	3·3	7·5	0·46	0·65	—0·467		11·8	15·1
10·9	3·4	7·5	0·44	0·62	—0·448		12·2	18·4
10·2	2·8	7·4	0·41	0·63	—0·500		13·0	9·1
10·2	2·9	7·3	0·42	0·61	—0·477		14·1	18·2
10·1	2·8	7·3	0·41	0·60	—0·455	12·8	14·1	17·3
9·7	2·4	7·3		0·62	—0·455		14·1	17·3
10·1	2·9	7·2	0·42	0·60	—0·451		15·3	17·9
10·0	2·8	7·2	0·41	0·58	—0·433	12·0	15·3	21·2
9·4	2·3	7·1	0·48	0·58	—0·425		16·1	22·7
10·1	3·0	7·1	0·41	0·64	—0·440		16·1	20·0
10·0	3·0	7·0	0·41	0·56	—0·433		17·7	21·2
10·0	3·0	7·0	0·38	0·54	—0·425		17·7	22·7
10·4	3·5	6·9	0·44	0·61	—0·430	9·2	18·2	21·8
9·6	2·8	6·8	0·39	0·57	—0·425		20·5	22·7
8·9	2·2	6·7	0·38	0·56	—0·420	14·0	21·2	23·6
9·8	3·6	6·2	0·41	0·54	—0·407	8·0	26·8	25·9
7·7	1·9	5·8	0·36	0·48	—0·377	9·2	31·8	31·4
5·9	1·9	4·0	0·25	0·37	—0·255		52·4	53·6
5·3	1·5	3·8	0·23	0·33	—0·220		55·3	60·0

SUMMARY OF TABLE C.

Results from legal samples of milk obtained during the last three years.

In 54 samples out of 63 the water shown by the freezing point is from 0·2 per cent. to 9·9 per cent. higher than that shown when calculated on 8·5 per cent. Solids not Fat, the average being 4 per cent. In 5 cases the calculation of added water on 8·5 per cent. Solids not Fat and the freezing point are practically identical.

In the other 3 cases the added water on 8·5 per cent. Solids not Fat is from 1·7 to 3·9 per cent. lower than by the freezing point. In the 3·9 per cent. case the acidity was not determined.

A. A. Bonnerna (Zeitzchrift fur Nahrungs und Genussmittel, 1908, X.V., page 34) points out an inaccuracy in Winter's formula for calculating the percentage of added water:

Suppose a milk to contain W per cent. of water, then the cyrstalloids which cause the depression of the freezing point in 100 grams of milk are dissolved in W

grams of water. If X grams of water are now added to 100 grams of milk, the cyrstalloids are dissolved in (W + X) grams of water.

Now let D be the observed freezing point of the diluted milk expressed in — degrees Centigrade then

$$X = \frac{0 \cdot 55 \times W}{D} - W$$

As the value W can easily be calculated when the percentage of Fat and the specific gravity are known, the value of X can also be obtained.

This formula, however, is not accurate from a theoretical point of view, because on diluting with water the electrolytic and hydrolytic dissociation of the salts is increased and consequently the freezing point decreased. This error is, however, sufficiently compensated for practical purposes if the calculation is based on the volume instead of the weight. The error thus introduced compensates the one arising from the increased dissociation.

Examples of Bonnerna's Formula.

MILK.

Specific Gravity	1·0142
Total Solids (weighed)	5·9
Freezing Point	—0.255

$$X = \frac{0 \cdot 55 \times 94 \cdot 1}{0 \cdot 255} - 94 \cdot 1$$

$$= \frac{(203 - 94 \cdot 1) \times 100}{203}$$

=53·64 per cent. Water by weight.

53·64 X 1·0142 = 54·4 per cent. Water by volume against 53·7 per cent. Water by volume calculated by Winter's formula.

MILK.

Specific Gravity	1·0298
Total Solids	11·97
Freezing Point	0·526

$$X = \frac{0 \cdot 55 \times 88 \cdot 03}{0 \cdot 526} - 88 \cdot 03$$

$$= \frac{(92 \cdot 04 - 88 \cdot 03) \times 100}{92 \cdot 04}$$

=4·35 Water by weight.

=4·48 Water by volume against
4·32 Water by volume according to Winter's Formula.

The following is a description of the method and apparatus that have been used in the Government Chemical Laboratory, Brisbane, for the last three years. The diagrammatic sketch shows the arrangement of the very simple apparatus required.

"A." is a stand made of wood 1 c.m. thick, 30 c.m. high, 31 c.m. wide and 18 c.m. deep. Two rests "B" at a height of 9 c.m. carry a movable shelf "C." on which the vessel containing the freezing mixture stands. We use a porcelain beaker "D" 16 c.m. high by 10 c.m. wide for a freezing vessel, and tie around it for insulation, a roll of flannel to the thickness of about one inch.

A circular hole "E." centrally situated in the top of the stand carries the milk tube "F." We use a flat bottomed tube 14 c.m. deep and 3 c.m. diameter for holding the milk sample. We find it much easier to get agreeing results with this size of tube than with the longer round bottomed tube recommended by Winter.

The indiarubber cork has two perforations for carrying thermometer and stirring rod respectively.

The first thermometer we used was a Beckmann graduated in $\frac{1}{100}$ths. The special thermometer devised by Winter for this work was subsequently obtained from Paris, but we found the Beckmann easier to read. For the last year, a thermometer graduated in $\frac{1}{100}$ths, a degree covering 8·5 c.m. of the stem, and specially made for us of normal glass by the V.F.L. has been used and gives splendid results. The trouble of having to occasionally readjust the mercury of the Beckmann has been avoided, while the true zero point which is determined afresh, at least once every day on which the thermometer is used, has not varied more than 0·02° C. A small telescope "H" is used for reading the thermometer. The telescope is mounted on the stand in the usual manner. The stirrer "K." is a brass rod 2 m.m. in diameter, the spiral part being partly flattened out and armed with four small points of wire to break up the ice formed in standardising.

In practice, 50 ccs. of each milk to be tested is put into a tube, fitted with a cork, and the tubes are put into crushed ice and allowed to remain there (generally standing in the

ice chest) until required. By this means the freezing of each sample is started close to 0° C. While the samples are cooling, the freezing mixture is prepared. The ice is conveniently prepared from the ice block by means of the usual ice plane. Alternate layers of ice and salt (3 : 1) are added until the porcelain beaker is filled. When about half filled, an empty "milk" tube is put into the middle of the beaker and the mixture packed around this tube. On removing the empty tube when the beaker is filled, there is no difficulty in inserting the tube containing the milk sample. After filling the beaker, the shelf is put in position on the rests and the beaker put on it. A tube containing a sample is then put through the hole in the top of the stand into the freezing mixture. The indiarubber cork is inserted, carrying the thermometer and the stirrer. The thermometer has been so adjusted that the bottom of the thermometer is about 2 c.m. from the bottom of the tube when the cork is in position.

The stirrer is now worked up and down continuously at the rate of from one to two complete movements per second to prevent the formation of a solid block of frozen milk in the tube as the temperature falls. As a rule the mercury will rapidly fall to a point below the true freezing point of the milk (surfusion of the milk), and then rapidly rise and become almost stationary; the highest point of the rise after the fall will be found to be very close to the true freezing point. When the tube has become partly filled with finely broken up frozen crystals—(experience with the method soon enables one to judge of the correct proportion of crystals to have in the liquid)—the porcelain beaker containing the freezing mixture is removed by withdrawing the shelf C and lowering the beaker and the hand put round the tube "G." so that its warmth may cause a rise in temperature, the stirrer being worked very gently until there is a rise of about $\frac{2}{100}$ths on the thermometer scale. The hand is now removed and the milk well stirred so as to surround the thermometer bulb with crystals of frozen milk.

The stirring is stopped and the temperature observed—the mercury will slowly fall, and when it becomes stationary the reading is taken, but should not be taken as final unless it remains constant for at least two minutes.

The position on the thermometer scale of the freezing point of water is determined in exactly the same way as in the case of milk, distilled water being first placed in one of the tubes "F." and cooled in a mixture of ice and water. Particular care, however, must be taken to break up the ice formed and to prevent the formation of a shell of ice round the sides and bottom of the tube. The fine ice should extend from the surface to the bottom of the thermometer bulb to ensure a good reading. It is much easier to determine the freezing point of a milk than that of water, owing to the fact that "milk" crystals are easily kept small, while water always tends to freeze in one lump. The difference between the freezing point of the distilled water and that of the milk on the thermometer, gives the freezing point of the milk.

For deducing the proportion of added water from the determined freezing point, the following table, extended from Winters, is used.

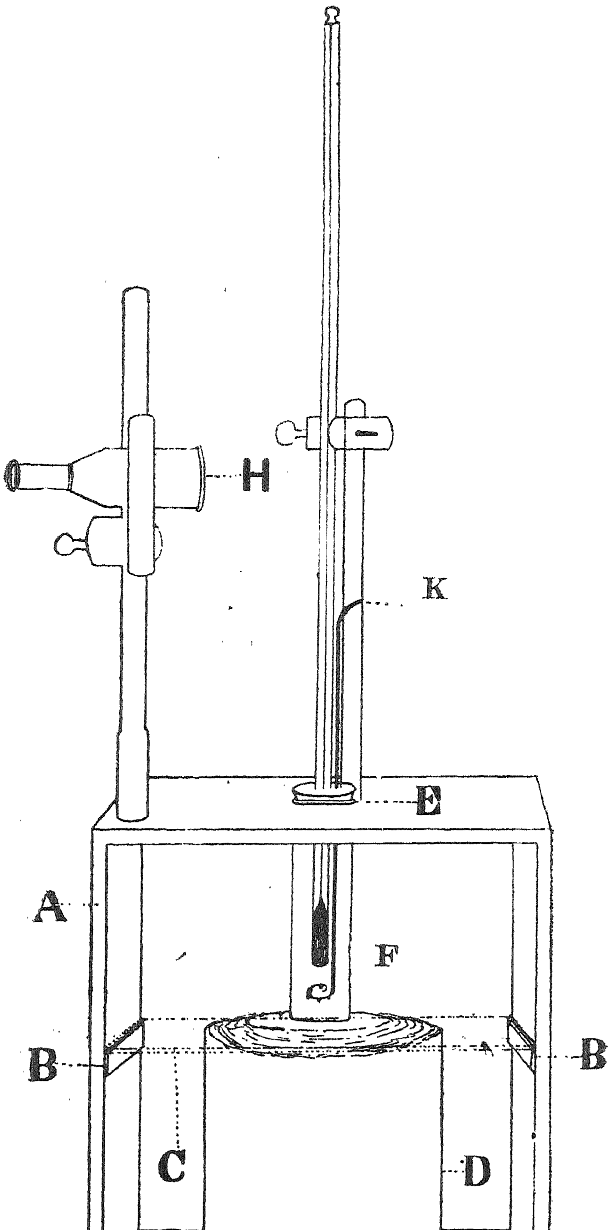
Table giving the number of ccs. of added water per Litre of Milk examined, corresponding to the temperatures —·550 to —·351° C. (Les nouveaute's chimiques pour, 1905 page 276, par Winter.)

Temperature observed. Degrees below zero.	ccs of added water in 1 Litre of Sample.	Temperature observed. Degrees below zero.	c cs of added water in 1 Litre of Sample.	Temperature observed. Degrees below zero.	c.c.s of added Water in 1 Litre of Sample.	Temperature observed. Degrees below zero.	ccs of added Water in 1 Litre of Sample.	Temperature observed. Degrees below zero.	ccs of added Water in 1 Litre of Sample.
·550	0	·510	72·7	·470	145·4	·430	218·2	·390	290·9
·549	1.8	·509	74·5	·469	147·3	·429	220·0	·389	292·7
·548	3.6	·508	76·4	·468	149·1	·428	221·8	·388	294·5
·547	5.4	·507	78·2	·467	150·9	·427	223·6	·387	296·4
·546	7.3	·506	80·0	·466	152·7	·426	225·4	·386	298·2
·545	9.1	·505	81·8	·465	154·5	·425	227·3	·385	300·0
·544	10.9	·504	83·6	·464	156·3	·424	229·1	·384	301·8
·543	12.7	·503	85·4	·463	158·2	·423	230·9	·383	303·6
·542	14.5	·502	87·3	·462	160·0	·422	232·7	·382	305·4
·541	16.3	·501	89·1	·461	161·8	·421	234·5	·381	307·3
·540	18.2	·500	90·9	·460	163·6	·420	236·4	·380	309·1
·539	20.0	·499	92·7	·459	165·4	·419	238·2	·379	310·9
·538	21.8	·498	94·5	·458	167·3	·418	240·0	·378	312·7
·537	23.6	·497	96·4	·457	169·1	·417	241·8	·377	314·5
·536	25.4	·496	98·2	·456	170·9	·416	243·6	·376	316·4
·535	27.2	·495	100·0	·455	172·7	·415	245·4	·375	318·2
·534	29.1	·494	101·8	·454	174·5	·414	247·3	·374	320·0
·533	30.9	·493	103·6	·453	176·4	·413	249·1	·373	321·8
·532	32.7	·492	105·4	·452	178·2	·412	250·9	·372	323·6
·531	34.5	·491	107·2	·451	180·0	·411	252·7	·371	325·4
·530	36.4	·490	109·1	·450	181·8	·410	254·5	·370	327·3
·529	38.2	·489	110·9	·449	183·6	·409	256·4	·369	329·1
·528	40.0	·498	112·7	·448	185·4	·408	258·2	·368	330·9
·527	41.8	·487	114·5	·447	187·3	·407	260·0	·367	332·7
·526	43.6	·486	116·4	·446	189·1	·406	261·8	·366	334·5
·525	45.4	·485	118·2	·445	190·9	·405	263·6	·365	336·4
·524	47.3	·484	120·0	·444	192·7	·404	265·4	·364	338·2
·523	49.1	·483	121·8	·443	194·5	·403	267·3	·363	340·0
·522	50.9	·482	123·6	·442	196·4	·402	269·1	·362	341·8
·521	52.7	·481	125·4	·441	198·2	·401	270·9	·361	343·6
·520	54.5	·480	127·3	·440	200·0	·400	272·7	·360	345·4
·519	56.3	·479	129·1	·439	201·8	·399	274·5	·359	347·3
·518	58.2	·478	130·9	·438	203·6	·398	276·4	·358	349·1
·517	60.0	·477	132·7	·437	205·4	·397	278·2	·357	350·9
·516	61.8	·476	134·5	·436	207·3	·396	280·0	·356	352·7
·515	63.6	·475	136·4	·435	209·1	·395	281·8	·355	354·5
·514	65.4	·474	138·2	·434	210·9	·394	283·6	·354	356·4
·513	67.3	·473	140·0	·433	212·7	·393	285·4	·353	358·2
·512	69.1	·472	141·8	·432	214·5	·392	287·3	·352	360·0
·511	70.9	·471	143·7	·431	216·4	·391	289·1	·351	361·8

SUMMARY.

(1). We find that the freezing point of pure fresh milk samples from herds of cows in Southern Queensland never shows a greater variation than from $-0.55°C$ to $-0.56°C$, the mean being $-0.555°C$. This is exactly in accord with Continental experience.

(2). The freezing point determines with accuracy, the proportion of water added to any milk from a herd, and distinguishes with absolute certainty the watered rich milk from the naturally poor milk.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